Final Report

Heavy-Duty Truck Evaporative Emissions Testing for Emissions Inventory

Prepared For The
California Air Resources Board
and The
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Abstract

Emission Factor Models are created to permit comparison of alternative strategies for reducing and maintaining ambient pollution levels. New vehicle certification testing methods were developed for light-duty cars and trucks in the 1990's. The new methods provide superior estimates of in-use evaporative emissions than those previously obtained. Little data using the new methods is available for in-use heavy-duty trucks. The purpose of this study was to measure evaporative emissions with a limited sample of the larger vehicles using the new vehicle certification protocols. The results will be used to confirm or improve corresponding Emission Factor Model inputs for this class of vehicle. Results of the testing were consistent with results obtained from light-duty vehicles when fuel tank size and vehicle age is considered.

Executive Summary

One of the Air Resources Board's (ARB) more important responsibilities is to recommend the specific methods to be used to achieve ambient air quality standards. Data regarding most air pollution sources have been consolidated by ARB into emissions inventories and models. These models are used to estimate the changes in ambient pollution levels that could be expected to result from changes in inputs to the environment. One of the largest sources of emissions is mobile sources, including motorcycles, cars and trucks. EMFAC 2001 is the current version of the model used by ARB to estimate emissions from mobile sources.

Historically, heavier gasoline-powered trucks were not considered major contributors to the overall evaporative emission inventory. Diesel powered vehicles do not contribute significantly to the evaporative emission inventory because of the properties of diesel fuel. The remaining gasoline-powered heavy-duty vehicles were a very small fraction of the remaining fleet. With time, however, very significant improvements have been made to the evaporative emission performance of the light-duty fleet. In addition, the sales penetration of trucks, vans, and SUV's has significantly increased, including those samples that cross the 8,500-pound boundary between light and heavy-duty emission control requirements. As a consequence, the contribution of the heavy-duty fleet has become significantly more important in relation to overall evaporative emissions.

The certification testing protocols used to control evaporative emissions have undergone major changes. These changes were implemented primarily to improve the stringency of the evaporative emission control system. As an added benefit, results of the tests using the new protocols provide a substantially improved measurement of actual in-use evaporative emission performance. This has provided the opportunity to correspondingly improve the Emission Factors Models.

Little data exists regarding the in-use evaporative emissions performance of larger gasoline powered trucks using the new testing protocols. The purpose of this project was to procure a small sample of in-use vehicles and to perform testing on the vehicles using the new test procedures.

Nine vehicles were procured and tested. Baseline tests were performed on each vehicle. Four additional tests were performed to evaluate repeatability, the effect of temperature, and the effect of repairs performed to the vehicles. Running Loss evaporative emissions were measured while test vehicles were operated on a dynamometer in a sealed enclosure. Hot soak tests followed the Running Loss test. A twenty-four hour variable temperature diurnal test followed the Hot Soak test.

Results were consistent with results of similar light-duty vehicles. Age, and resulting emission control device failures, had the greatest impact on results. Older technologies, even when well maintained, do not control evaporative emissions as well as newer technologies. Larger fuel tanks tend to result in higher evaporative emission levels than smaller capacity tanks. Higher temperatures result in higher evaporative emissions.

The results of this program are available to EMFAC 2001 modelers to confirm or improve factors being used for the heavy-duty gasoline powered class of vehicles.

Heavy-Duty Gasoline Truck Evaporative Emissions Testing for Emissions Inventory

June 4, 2002

I. Introduction

Vehicle emission testing procedures and standards have continuously evolved since their development in the 1960's and 1970's. When vehicle emissions were initially sampled, the relative contribution of trucks was small. The much larger light-duty vehicle population overwhelmed the truck population in both number and total miles traveled. Control of the smaller population was not given the priority the larger sources were. It was similarly apparent that exhaust emission control was a much more beneficial target than evaporative emission control. Initial efforts focused on exhaust emissions, and were met with great success. Continued pursuit has resulted in passenger car emissions more than a full order of magnitude lower than baseline levels, with additional substantial reductions being phased in with current and near future production vehicles.

As experience was gained with vehicle emission sources and the mechanisms available to control them it became apparent that significant reductions in hydrocarbon emissions were available from control of evaporative sources at a relatively low cost. A goal of zero emissions from vehicle fuel evaporation was established, and the charcoal vapor canister became a universal component of light-duty vehicles sold in California, and later the remaining United States. The procedures used to measure evaporative emissions evolved from attaching charcoal canisters to suspected vapor sources, to a fixed temperature whole vehicle enclosure, and currently to a variable temperature, extended time vehicle enclosure. Evaporative emissions occurring during engine operation (running losses) were initially not measured, but are now included in new vehicle emission testing required for certification.

Each of these processes resulted in major reductions in emissions from the light-duty fleet, making heavy-duty vehicles a larger relative source. At the same time, the sale of heavy-duty vehicles has increased dramatically, making this class of vehicle an even more important part of the ambient air quality problem.

Regulators and legislators are faced with the task of selecting what methods will be used to achieve ambient air quality levels. Knowledge of the source of ambient pollutants is required to make informed decisions. Detailed inventory models have been developed by air pollution control agencies to assist in the decision making process. Measurements of the known sources of various pollutants have been gathered and combined into a variety of tables and computer programs, which allow some comparison of the relative contribution of each source. One such model is the California EMFAC 2001 model, which is used to estimate the contribution to ambient emission levels from mobile sources. The primary source of data for the inventory model is the results of the laboratory tests like those used to certify new motor vehicles. These procedures are used to evaluate both preproduction prototypes and in-use vehicles after time. As a direct consequence of improvements in certification testing protocols, the quality of the inventory model has improved. Recent major changes have been made in the testing procedures for cars and trucks, which have resulted in the potential for substantial improvements in the evaporative emission inventory model for these classes of vehicles.

Until recently, heavy-duty trucks have not enjoyed the benefits of these protocol changes. Initially, this class of vehicle was not considered as significant a contributor as the light-duty vehicle. As emissions from the higher production vehicles have dropped, the relative contribution of the remaining sources has increased. The number of heavy-duty vehicles produced was initially a relatively small fraction of the fleet. The Gross Vehicle Weight Rating (GVWR) cut point between light and heavy-duty was increased from 6,000 pounds to 8,500 pounds to include vehicles in this GVWR range in the more stringent light-duty vehicle emission class. Many noncommercial trucks, and now SUV's, are found with GVWR greater than 6,000 pounds. Fleet growth and demographics have changed, however. The vast majority of 8,500+ GVWR vehicles in the early 1960's and 70's were commercial vehicles used by businesses, and necessary to perform their business. Emission test procedures and standards were established to equitably control these low production, primarily commercial vehicles. Emission standards and procedures for these vehicles have since been aligned with the light-duty class, but it will be several years before heavy-duty vehicles certified to the more stringent procedures begin to dominate the in-use heavy-duty fleet.

Summarizing, initial focus was placed on reducing emissions from the largest segment of the in-use vehicle population. A reduction in emissions from the light-duty class of vehicles has magnified the relative emissions of larger vehicles. The entire mobile source population has grown, increasing the number of heavy-duty vehicles. In addition, the fraction of trucks in the new car population has grown. The test procedures used for what was once a relatively insignificant fraction of the mobile source population have only been recently aligned with those used for light-duty vehicles.

The purpose of this study was to collect evaporative emissions data using the current "enhanced" test procedures on a limited sample of vehicles from the in-use heavy-duty truck population. The results are to be used to either validate or adjust the previous EMFAC 2001 emissions inventory model assumptions and extrapolations. The results may indicate the need for additional testing.

II Materials and Methods

The major factors influencing evaporative emissions include the specific vehicle samples selected, the fuel used for testing, and the specific test protocols used. Details of each of these factors will be reviewed in this section

A. Test Vehicles

Each vehicle in this program was gasoline powered. They were typical of the vehicles in the groups they represented. The test program originally specified that either California or Federally certified vehicles could be used. This was later clarified to require that the vehicles tested were to have been certified to meet California evaporative emission requirements in effect at the time of manufacture.

The specific vehicles selected were further categorized with respect to technology and GVWR class. Light-duty vehicles are those with GVWR less than 8,501 pounds. No light-duty vehicles were tested in this program. Heavy-Duty gasoline powered vehicles are subdivided for inventory purposes into three groups: Light Heavy-Duty Gasoline Trucks (LHDGT), Medium Heavy-Duty Gasoline Trucks (MHDGT), and Heavy Heavy-Duty Gasoline Trucks (HHDGT). The GVW weight cutoffs for these groups are 8,501 to 14,000 pounds for the LHDGT, 14,001 to 33,000 pounds for the MHDGT, and 33,001 pounds for the HHDGT. As more than 99% of the HHD (>33,000 pound) vehicles are diesel powered, no vehicles of this category were procured or tested for this program.

Emission regulations, and the engine technology used to achieve the standards, have evolved over time. The vehicle sample tested in this program was further subdivided by model year groupings corresponding to different emission control standards and the technologies used to achieve them. 1972 through 1979 vehicles were required to meet a 2.0-gram Carbon Trap test (equivalent to a 6.0 gram SHED[1] test). 1980-1985 trucks were required to meet a 2.0-gram SHED, but were generally carbureted.

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1 Sealed Housing for Evaporative Determination (SHED). Description to be discussed in test methods section of report.

Vehicles manufactured after 1990 are generally equipped with electronic fuel injection. This permits superior fuel control for reduced exhaust emission and improved fuel economy. 1986-1989 represents a transition period between carbureted and fuel injection technologies. The vehicle sample was stratified to obtain samples from the different subgroups as indicated in Table 1.

Table 1.
Test Fleet

Number Of Vehicles	Class	Model Year	Fuel System	Evaporative Emission Standards
1	LHDGT	1972-1979	Carbureted	2.0 Carbon Trap
2	LHDGT	1980-1985	Carbureted	2.0 SHED
1	LHDGT	1986-1989	Either	2.0 SHED
3	LHDGT	1990+	Fuel-Injected	2.0 SHED
1	MHDGT	1972-1979	Carbureted	2.0 Carbon Trap
1	MHDGT	1980-1985	Carbureted	2.0 SHED
1	MHDGT	1986+	Fuel-Injected	2.0 SHED

Additional restrictions included limiting a specific manufacturer to a maximum of 3 samples of the LHDGT and 2 samples of the MHDGT, and requiring annual mileage accumulation rates of 10,000 miles per year.

The actual vehicles tested, including detailed vehicle identification data, are tabulated in Appendix I. The required distribution of manufacturers was met. Not every vehicle met the required odometer rate. Each vehicle was proposed to ARB staff and accepted prior to procurement.

Vehicle procurement was complicated by several factors. ATL's original proposal assumed that appropriate vehicles could be located in the Phoenix metropolitan area, where we have extensive vehicle procurement contacts. At the time of the proposal, ATL was actively performing a similar testing program for the USEPA involving dynamometer testing of LHDGT, including FTP and SFTP test cycles. We intended to add the evaporative testing required for this program to the ongoing EPA effort. The

EPA program ended before the CARB program was awarded, precluding that possibility.

During final planning it was agreed that all of the vehicles for this program were to have been originally equipped with the evaporative equipment required for California. The engine and evaporative families of proposed candidates were to be forwarded to ARB and approved prior to procurement. A number of vehicles were located and identified, both in Arizona and California, and passed over for lack of identification (missing and/or illegible stickers), or lack of evaporative control equipment. We decided to focus all procurement efforts for the final vehicles in California. Several trips were made to the Los Angeles and San Diego areas, in conjunction with other programs and as stand-alone trips. An ongoing search of the Internet seeking qualified vehicles for sale was performed. The remaining vehicles were located, proposed, procured, and tested with the exception of the 1980-1985 MHDGT. During the final summer, on two occasions a qualified vehicle was identified and accepted by ARB, but the vehicle owners backed out when a trip was made to pick up the vehicle. Two contract extensions were permitted, but time ran out before the tenth truck was tested.

B. Test Fuel

The properties of the test fuel significantly affect the results of gasoline evaporative emission tests. Commercial gasoline was purchased in barrels from a supplier in California. The fuel was standard grade, summer time fuel intended to meet all California Phase II properties and regulations.

The barrels were shipped from California to ATL's Mesa, Arizona testing facility. They were stored in a refrigerated barrel storage area until used. Samples were collected and delivered to an independent testing laboratory and to ARB's El Monte laboratory for analysis and to confirm compliance with California Phase II specifications. Results of these analysis tabulated are in the results section of this report.

C. Test Protocols

Emission testing was performed, as appropriate and possible, using the methods and protocols currently specified for new light-duty vehicles. A recap of the development of current testing procedures is provided to establish a framework for previous work and the current effort. The section concludes with a detailed summary of the protocols used for this program.

Evaporative testing methods have evolved with time. California has generally implemented changes earlier than the remaining 49 states, but has used the procedures eventually published by the USEPA in the Code of Federal Regulations (CFR). 40 CFR 85 defines the exhaust and evaporative emission procedures required for 1976 and earlier light duty vehicles. Exhaust and evaporative tests were (and continue to be) run as a single combined sequence, with exhaust measurements performed at some points and evaporative emissions performed at others. The elements related to evaporative emissions (as described at 40 CFR §85.074) include:

- Operate the vehicle for one hour immediately before the start of testing.
- Drain and fill the tank to 40% capacity.
- Operate for 7.5 mile trip on dynamometer
- Soak for minimum of 10 hours
- Drain fuel tank, refill with fuel between 58 and 62°F
- Plug exhaust pipes, inlet to air cleaner, and vent all suspected fuel vapor sources to carbon collection canisters.
- Artificially heat fuel in tank from nominal 60°F start to +24°F rise in 60 ± 10 minute time. (Diurnal Segment)
- Clamp vapor traps for exhaust test
- Perform exhaust test
- Unclamp vapor traps
- Soak vehicle one additional hour (Hot Soak Segment)
- Clamp and weigh vapor traps to determine net wet gain.

Interestingly, the early procedure specifically requires "running loss" testing to be performed unless all suspected vapor sources are vented "in the immediate vicinity of the carburetor air horn". As a result, vapors generated during engine operation would be expected to be drawn into the operating engine, and vapor collection is specifically not required. This is the "Canister Trap" protocol, with a limit of a 2.0 gram increase in weight of all carbon traps for light duty vehicles.

A major change was implemented for the 1977 model year. A whole vehicle enclosure was added for the Diurnal and Hot Soak segments. This enclosure (the SHED) permitted free venting and capture of all hydrocarbon vapors from the vehicle. The SHED design tolerated only limited expansion and contraction from changes in temperature, but greatly improved the collection of evaporative emissions. The test sequence remained the same, but the diurnal and hot soak segments were now performed in the sealed enclosure. No plugs or traps were used. The certification standard was initially raised to 6.0 grams to allow for increased stringency with the new procedure, but then returned to a 2.0 gram limit.

As time passed it became apparent that the SHED procedure did not totally control evaporative emissions. Atmospheric sampling did not reflect the reductions in evaporative emissions expected from the implementation of the SHED test regulations. Additional research revealed, for example, that extending the duration of either the hot soak or diurnal test resulted in dramatic increases in evaporative emissions measured. Suspicion that all running losses were not actually captured by engine induction lead to the development of a dynamometer enclosed in a SHED, with very substantial running losses measured. Fuel properties had changed following the introduction of the catalytic converter and the requirement for unleaded fuel. Tests performed with commercial fuels resulted in very substantial increases in measured evaporative emissions when compared to the 1975 baseline fuel used for emission testing. Industry sponsored testing with a 24 hour diurnal test, in which the air surrounding the vehicle was controlled to a 24 hour temperature profile, yielded substantially higher evaporative emissions than the one hour fuel heating test. Repeated diurnals, as observed when a vehicle is not operated over a weekend, additionally proved to yield higher evaporative emissions.

The certification protocols were again reviewed. California again broke new ground with implementation of the current evaporative testing procedures, to be followed by federal standards starting with the 1996 model year. In addition, controls of fuel properties were implemented both nationally and particularly in the State of California, to further control exhaust and evaporative emissions.

Two major changes were implemented with the new regulations. Diurnal emissions are now measured in an enclosure that can tolerate the volume changes that occur with significant air temperature changes, and running losses are measured during dynamometer operation.

Detailed procedures specifying the equipment, procedures and tolerances for these tests are specified in 40 CFR 86 subpart B. California has adopted these procedures in its state regulations, except with respect to model year of implementation, fuel requirements, and the temperatures used.

For regulatory purposes, California has chosen extreme temperatures. The higher temperature range used for certification forces additional vapor storage capacity to be included in vehicle design. For example, the daily ambient temperature swing in the federal procedure is 72 to 96 to 72°F in a smooth 24-hour pattern. The corresponding ARB cycle is 65 to 105 to 65°F in the same 24-hour period. Diurnal emissions result primarily from the expansion and displacement of vapors in the fuel tank. The rise from 72 to 96°F displaces less vapor than the 65 to 105°F temperature cycle.

For inventory purposes, it is more appropriate to select a temperature cycle typical of those actually experienced in the area being modeled. The inventory model can, if appropriate, apply correction factors to estimate emissions on days with more extreme temperature variations. For this program, it was agreed that the 72 to 96°F federal cycle would be used as the baseline test condition.

The entire certification testing protocol includes extensive refueling, canister preconditioning, and exhaust emission testing. The following summarizes the procedure used for this "emission factor" testing:

- Drain and fill the tank(s) to 40% capacity.
- Operate for 7.5 mile trip on dynamometer (or road)
- Soak for minimum of 12 hours
- Perform running loss dynamometer test (or road operation)
- Soak vehicle three additional hours (Hot Soak Segment)
- Soak a minimum of six hours at diurnal start temperature
- Perform 24 hour diurnal test

Running Losses

Running loss emissions are measured on a dynamometer in a SHED enclosure. ATL's running loss SHED is equipped with a dynamometer capable of simulating 9,875 pounds of vehicle weight. The LHDGT vehicles are specified to have GVWR of 8,501 to 14,000 pounds. While the total weight of the vehicle and load is 14,000 pounds, the actual empty weight of the vehicle rarely exceeds 10,000 pounds in this class of vehicle. To provide some measure of the running losses of heavy trucks, dynamometer testing was performed on the LHDGT vehicles using the measured curb weight of the vehicle plus 300 pounds. It should be noted that current exhaust emission testing with lighter trucks requires curb weight plus half payload for the dynamometer inertia setting. (Payload is the difference between empty curb weight and GVWR). No attempt to load above 10,000 pounds was made for this program. Reasonable road load settings for the LHDGT trucks were computed using the frontal area calculations specified in 40 CFR §86.129-80.

Running loss standards are established on a gram/mile basis. Actual running losses observed during a test are generally non-linear, meaning this gram/mile measurement would not be the same during the first 10 minutes of vehicle operation as during the final 10 minutes. The regulations are based on a 70- minute drive. For inventory modeling purposes, it is more appropriate to incorporate a sliding scale for running loss results that accounts for the number of minutes of operation. For this program, the driving schedule selected (by the test sponsor) was three repetitions of the Urban Dynamometer Driving Schedule (UDDS), followed by a 30 minute shutdown, followed by a final UDDS schedule after restart. The UDDS is the basis of the standard light duty exhaust emission test, and the city-driving portion of the fuel economy regulations. All data was collected continuously, and is available electronically on a minute by minute basis.

A critical factor in running loss testing is the temperature of the fuel during the driving event. The CFR regulations specify that fuel temperature targets must be established by operating a vehicle on an outdoor track while using the same driving schedule as is used during dynamometer testing. Each of the LHDGT vehicles in this program were instrumented with fuel temperature thermocouples and operated on a closed course using the dynamometer driving schedule while fuel temperature was recorded. Target fuel temperatures were extracted from these results using the CFR procedures. During the running loss evaporative test, a temperature controller was programmed with the target temperatures on a minute by minute basis. The automatic controller operated a fan and heater to maintain fuel temperature during the test within the specified fuel temperature tolerances.

Testing of the LHDGT vehicles began with a drain and refill to 40% of tank capacity with the commercial California Phase II fuel procured for this program. They were then operated on a dynamometer over one UDDS cycle (23 minutes, 7.5 miles). The vehicle was then placed in soak (key off) at an ambient temperature of 95°F for a period of 12 to 24 hours. The vehicle was pushed into the dynamometer/SHED enclosure and permitted to soak the final one-hour (minimum) prior to the test. The fuel temperature at the end of the soak was required to meet the nominal ambient temperature within ± 2F°. An ambient target of 95°F was used for all baseline tests in this program. One replicate test was performed on ARBHDT04 using target temperatures of 75°F for the running loss and hot soak tests for comparison.

Fresh air was ducted to the engine inlet in the running loss enclosure. Vehicle exhaust was ducted through the wall to a Constant Volume Sampler (CVS). This isolated the engine emissions from the evaporative hydrocarbon emissions. CO_2 was monitored in the evaporative enclosure to insure that the exhaust system was leak tight. CO was similarly monitored to insure driver safety. HC was measured continuously and electronically logged for the evaporative running loss computation and report.

All instrumentation in the running loss cell was electronically controlled by the Horiba SADA driver's aid. The driver would start the vehicle's engine and activate the driver's aid. The SADA actuated the CVS and fuel temperature controller automatically. An operator outside of the test cell would mark charts and observe the vehicle and driver for safety.

Exhaust emissions were transported to a continuous dilute monitoring bench and electronically logged. Bag samples were collected at the running loss SHED, and transported to the dilute continuous bench for quality control comparison. All second by second and minute by minute results have been presented to the ARB project engineer, but will be collected into a single CD ROM recording.

The MHDGT's exceeded the capacity of the dynamometer in the running loss enclosure. These vehicles were operated on a road course similar to the UDDS schedule for preconditioning. Initially, they received a drain and fill to 40% capacity, and then were operated for one lap of the 7.5 mile road course for preconditioning. They were soaked overnight at 95°F for 12 to 24 hours.

The vehicles were started and operated outdoors in a manner paralleling the running loss test performed on the LHDGT vehicles. They were operated for three consecutive road UDDS equivalents, soaked with the key off for 30 minutes, and then operated for a final UDDS equivalent. The drive was coordinated with the test operator to permit the vehicles to immediately enter the laboratory and proceed on with hot soak testing at the end of the final UDDS cycle.

Hot Soak Testing

A Hot Soak test was initiated immediately following the running loss or road operation on all vehicles. The Hot Soak SHED enclosure is operated at one nominal temperature for the duration of the test. All baseline tests in this program used a 95°F set point. The HC analyzer was calibrated immediately prior to the start of the test, the enclosure was ventilated to provide a stable initial background, and the temperature was allowed to stabilize at the set point.

Test vehicles were transferred to a Hot Soak enclosure immediately after completion of the running loss test or road warm-up. The SHED door was sealed, and a continuous recording of SHED parameters was initiated. The Hot Soak continued for three hours. The continuous recording and three hour duration was used to more permit more realistic modeling of actual hot soak events. The regulations are based on a one-hour hot soak, with results computed only at the end of the one-hour period. Hot Soak emissions, like running loss emissions, are typically non-linear, and are more appropriately modeled on a unit time basis (minute by minute, hourly, or other).

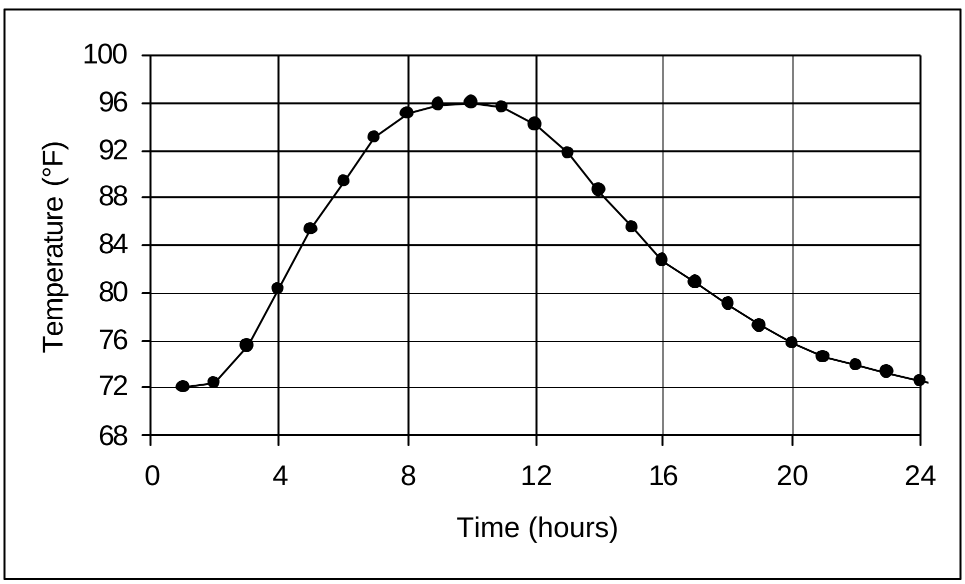
Diurnal Testing

A diurnal temperature cycle of 72 to 96°F was selected as the baseline sequence for this program. All vehicles were soaked at the 72°F initial diurnal temperature following completion of the Hot Soak test. They were left to soak at this temperature a minimum of 6 hours prior to the start of the diurnal sequence.

The Diurnal tests were performed in SHED enclosures capable of operation at variable temperatures (VT SHED). The tests for this study used the temperature cycle specified for federal new car certification. This cycle starts at 72°F (typical of a warm evening), rises smoothly to a peak of 96° after nine hours (typical of diurnal temperature rise between 6:00 am and 3:00 pm), then falls smoothly over the next 16 hours to return to 72°F (as would happen during the late afternoon and evening hours). Table 2 tabulates the hourly diurnal temperature targets.

Table 2.
Diurnal Temperature Cycle

Time (hrs)	Temperature (°F)	Time (hrs)	Temperature (°F)
0	72.0	13	88.6
1	72.5	14	85.5
2	75.5	15	82.8
3	80.3	16	80.9
4	85.2	17	79.0
5	89.4	18	77.2
6	93.1	19	75.8
7	95.1	20	74.7
8	95.8	21	73.9
9	96.0	22	73.3
10	95.5	23	72.6
11	94.1	24	72.0
12	91.7		



The diurnal SHED is designed to accurately simulate the fuel tank heating and cooling observed by a vehicle parked out-doors with unrestricted under-vehicle air movement. A fan is used to create a 5-mph wind under the test vehicle, including particularly the air under the fuel tank. A thermocouple under the vehicle is used as the temperature monitoring and control point for the diurnal test.

When air is heated or cooled, it expands and contracts. The change in internal pressure caused by the temperature changes would cause a standard fixed volume SHED to fail. Two methods are permitted to compensate for the volume changes in a VT SHED. Both methods are incorporated in the SHEDs used by ATL. The first method permits changes in the enclosed volume. This variation can be permitted with rigid panels that move, or flexible bladders that are vented to the exterior of the enclosure and allowed to "breathe" in response to temperature and barometric pressure driven changes. The bladder method is used in three of ATL's SHEDs. The bladder is inflated prior to the start of the test to a known volume. The SHED is stabilized at the initial temperature of the upcoming diurnal test. The vehicle is soaked at this temperature for a minimum of six hours, typically in the SHED enclosure. The SHED is ventilated prior to the start of the test, minimizing the background HC levels in the enclosure at the starting point of the test. A continuous recording of temperature, pressure, and hydrocarbon level is initiated prior to the start of the test. The SHED door is sealed, an initial temperature, pressure, and hydrocarbon level is recorded, and the bladders are opened to the atmosphere. The programmed temperature cycle is initiated, and the test proceeds for the next 24 hours.

A very similar process is used in ATL's two remaining VT SHEDs. These enclosures provide temperature compensation by withdrawal of air from the enclosure at a measured rate that exceeds the maximum expansion caused by the test temperature variation. A critical flow venturi (CFV) is used in ATL's design. A gas pressure regulator is then used to meter make-up air into the enclosure to replace the air withdrawn. The removal rate is greater than that required to compensate for thermal expansion and contraction. The hydrocarbon levels of the air entering and leaving the enclosure are measured continuously. Hydrocarbon mass added to the enclosure in the makeup air is subtracted from the vehicle total. Mass removed from the enclosure is added back into the total, while the mass of hydrocarbon in the enclosure is computed using standard methods. The sequence of stabilizing the vehicle and temperature in the SHED, sealing the door, logging the readings, and cycling the temperature exactly parallels the other SHED design. This design is more appropriate for the higher hydrocarbon levels with in-use vehicles as the constant dilution of air in the SHED avoids the very elevated HC levels observed in smaller SHEDs of the bladder design.

Extensive quality control review of all data and testing procedures was performed following completion of the diurnal test. All test documentation was reviewed to insure compliance with required test sequence, soak times, fuel fills, and temperatures. Electronic data files were reviewed to insure proper zero and span settings, and return to zero and span following completion of the test. Extensive daily, weekly, and monthly calibrations are performed on all dynamometer and evaporative testing equipment. Frequency and tolerances applied meet or exceed 40 CFR 86 requirements.

Post Test Inspection

Prior to acceptance for testing, identifying numbers and a description of the evaporative emission control system was reviewed with ARB staff. Great care was exercised to avoid making any change to the vehicle that could affect the evaporative emissions observed with the vehicle during testing. Results of testing were reported to ARB staff and accepted before continuing.

The vehicles were then subjected to a comprehensive inspection and documentation of vehicle condition. Components such as vapor hoses were removed during the inspection, possibly changing the condition of the vehicle. Two fundamental tests of evaporative system integrity were performed on each vehicle. The first verifies that all connections and hoses are leak tight. The tank vapor line to the canister was disconnected, and pressurized air was applied to the tank and cap. Pressure was fed until a stable 14 to 15" of water pressure was captured. The vapor line was then clamped, and pressure drop recorded. This protocol was required prior to the implementation of whole vehicle testing in a SHED, and remains an excellent diagnostic tool. Any significant leak in this system results in high evaporative emissions. Pressurizing from the canister results in a parallel check of the vapor hoses, the fuel tank(s) and the fuel tank cap(s). Most of the vehicles in the program had dual tanks.

The second test verifies purge flow. A rotometer was placed in series between the vehicle engine and the evaporative control canister. Air was drawn by the operating engine through the canister to remove hydrocarbon mass stored in the canister during previous engine off events. Purge flow is typically controlled by temperature or vacuum switches (in older vehicles) or electronic computer controlled solenoids (in modern vehicles). Component failure, line misrouting, plugged lines, or disconnects can all prevent proper purge of the storage canister, which will consequently fill to capacity with hydrocarbon mass and will no longer prevent escape of additional vapors to the atmosphere.

Inspection of all vapor and liquid fuel lines were performed, as well as a visual inspection of all evaporative control components. As running loss and extended diurnal testing was not specified for certification of the older vehicles, additional measurements and configuration data was recorded. Current vehicles must control the temperature of the fuel in the fuel tank during engine operation to minimize running losses. Sketches of the vehicle configuration and the relationship of components affecting evaporative emissions were collected during the post test inspection. The distance between the hot exhaust system and the fuel tank(s) was recorded. A sketch of the overall configuration was made. A description of the control system was included, as well as the results of all system checks.

The mechanic/inspector was provided with the results of the as-received tests, and was instructed to find the cause of any unusual observations.

Restorative Maintenance and Replicate Tests

Baseline tests were performed on all vehicles. Four additional tests were completed. One test was performed using all procedures and temperatures used for the baseline tests – a replicate test to assess repeatability. A second test was performed using the same procedures, but dropping the target temperature of the running loss and hot soak tests from 95 to 75°F, to quantify the impact of those parameters. The final two were performed following repairs to failures in the evaporative control systems of two vehicles. These repairs were performed to assess the potential for reductions available through maintenance of vehicles of this class. Inspection and repair has been demonstrated to have a significant impact on the evaporative emission levels from the light-duty fleet, including the finding that many older vehicles have very large evaporative emissions resulting from small liquid fuel leaks.

III. Results

In this section of the report specific descriptions of the vehicles procured will be provided. Test results will be presented, followed by inspection results.

A. Test Vehicles

The nine trucks procured and tested for this program provide a good cross section of the population of interest. Technology in the newer samples is quite similar to that used in the light duty population, including extensive computer control. The older units show signs of engine swapping and maintenance that exceeds what would be expected of a similar vintage light-duty automobile, but correspond to what would be appropriate for a commercial vehicle. These were “working” vehicles.

Appendix I provides detailed vehicle identification data. In addition to model year and manufacturer, the Vehicle Identification Number (VIN), Engine Family, and Evaporative Family are tabulated.

Appendix II provides additional detail. Here vehicle specifications, including engine size, GVWR class, fuel induction class, fuel tank material, tank capacity, transmission type, and build date are listed. The vehicles meet the specifications and requirements listed in Table 1, except for the lack of the middle vintage MHDGT.

B. Test Results

Test results are briefly summarized in Table 2. A cursory inspection reveals three order of magnitude differences between the vehicles. These results are not the highest or the lowest ever recorded for in-use vehicles. The range is typical, and to be expected given the fuel tank capacities recorded and the defects found with the vehicles.

Table 3.
Results Summary

	Running Loss		Cumulative Hot Soak Hr 1	Hr 2	Hr 3	24-hour DHB	
Veh #	**Grams**	**Gram/mi**	**Grams**	**Grams**	**Grams**	**Grams**	**Condition**
01	8.72	0.29	1.02	1.17	1.30	9.05	Baseline
02	30.64	1.02	0.41	0.57	0.69	19.49	Baseline
03	2.71	0.091	0.93	1.43	1.81	5.65	Baseline
	2.97	0.100	1.17	1.71	2.10	4.19	Replicate
04	0.38	0.013	0.09	0.12	0.15	0.92	Baseline
	0.18	0.006	0.06	0.09	0.10	0.87	75°
05	-	-	2.44	3.05	3.52	39.37	Baseline
06	-	-	48.34	64.88	78.08	54.54	Baseline
07	110.39	3.70	14.46	20.64	24.97	38.76	Baseline
	20.67	0.70	7.28	9.93	11.82	30.11	After Repair
08	54.59	1.83	14.11	15.45	16.18	43.35	Baseline
	8.69	0.29	3.01	4.58	5.60	10.14	After Repair
09	23.23	0.78	1.83	3.77	4.02	15.81	Baseline

Vehicles 05 and 06 were MHDGT vehicles. No running loss tests were performed on this class of vehicle. All remaining vehicles were LHDGT.

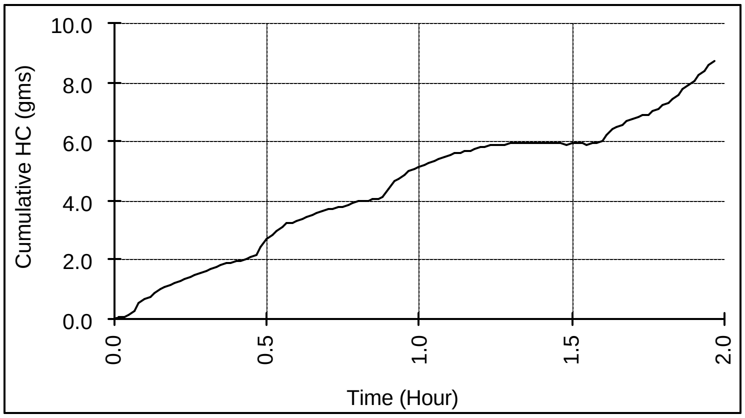
The repeat test sequence on vehicle 03 is a replicate – no changes in procedure or parameters existed between the tests. The running loss results differed by approximately 10%. At the end of three hours, the hot soak results differed by about 17%. These variations are consistent with the results of other vehicles with emissions at these levels. The largest difference noted was in the 24-hour diurnal, approximately 35%. This difference would be higher than expected for a properly functioning vehicle, but is not extraordinary for a high emitting vehicle. Malfunctions, including those resulting from age and high mileage, increase observed variation in both evaporative and exhaust emissions of high emitters.

The second test on vehicle 04 is a repeat of the baseline except the temperature set point for the running loss and hot soak tests was 75°F instead of 95°F. The running loss test dropped substantially at this temperature. The lower temperature used for the running loss test was also reflected in the target fuel temperature profile, resulting in a 20 degree fuel temperature reduction throughout the test. The hot soak and diurnal dropped also.

Figures 1 through 9 summarize the results of the individual tests graphically.

Figure 1 - Vehicle 01 Results
Vehicle: ARBHD01 (LHDGT): 1989 Ford F350, 7.5L, PFI, 15+23 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

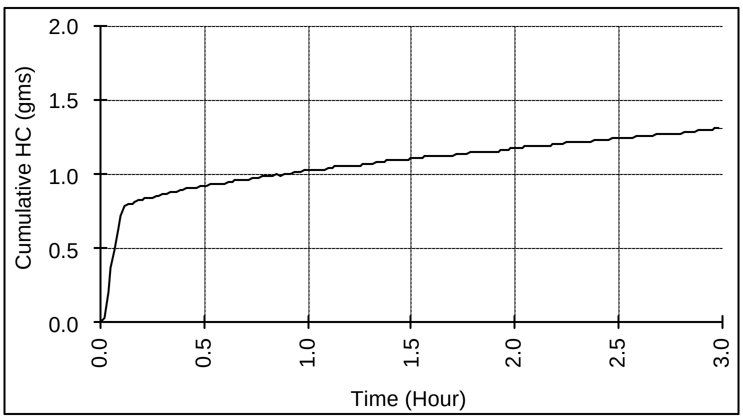


Baseline

Test#: 23192
Length: 118 min.
Temp: 95°
Date: 6/01/00
Dist: 29.71

Grams: 8.72
Gms/mile 0.29

HOT SOAK EVAPORATIVE EMISSIONS TEST

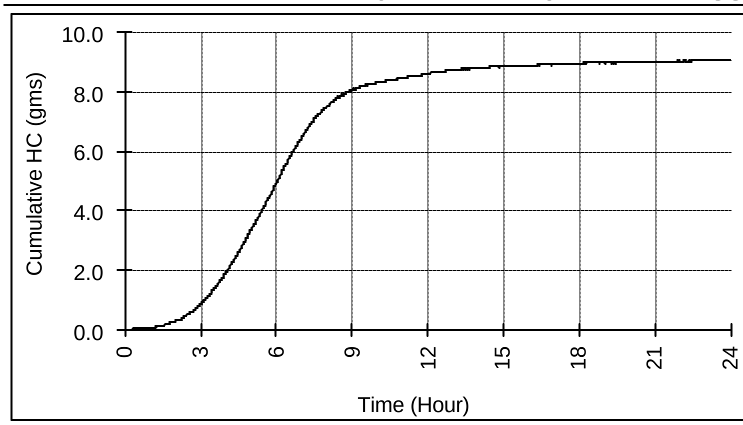


Baseline

Test#: 3477
Length: 3 hrs.
Temp: 95°
Date: 6/01/00

Grams: 1.30

DIURNAL EVAPORATIVE EMISSIONS TEST



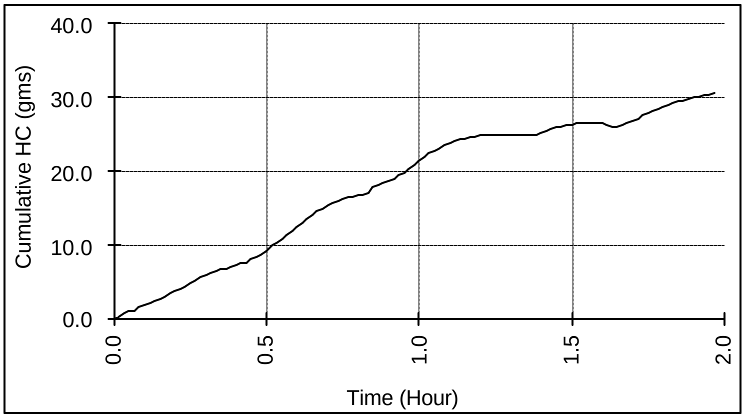
Baseline

Test#: 3479
Length: 24 hrs.
Temp: 72-96
Date: 6/02/00

Grams: 9.05

Figure 2 - Vehicle 02 Results
Vehicle: ARBHD02 (LHDGT): 1990 Ford F250, 5.7L, PFI, 23+19 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

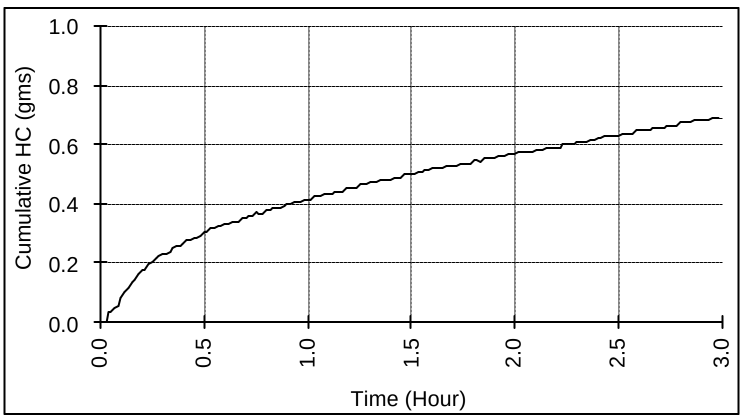


Baseline

Test#: 23453
Length: 118 min.
Temp: 95°
Date: 7/19/00
Dist: 29.90

Grams: 30.64
Gms/mile 1.02

HOT SOAK EVAPORATIVE EMISSIONS TEST

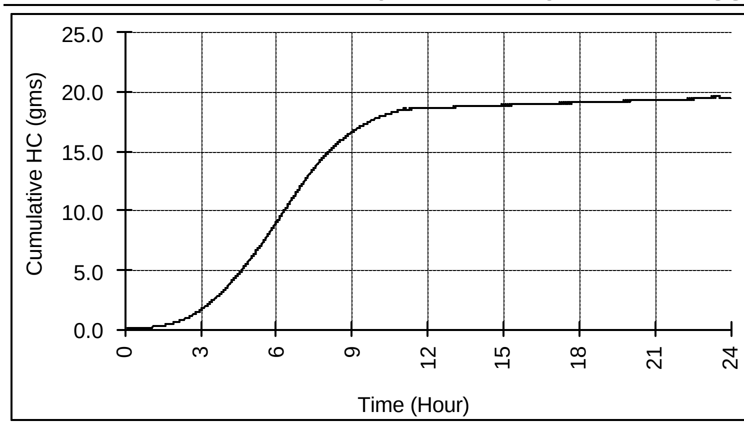


Baseline

Test#: 3494
Length: 3 hrs.
Temp: 95°
Date: 7/19/00

Grams: 0.69

DIURNAL EVAPORATIVE EMISSIONS TEST



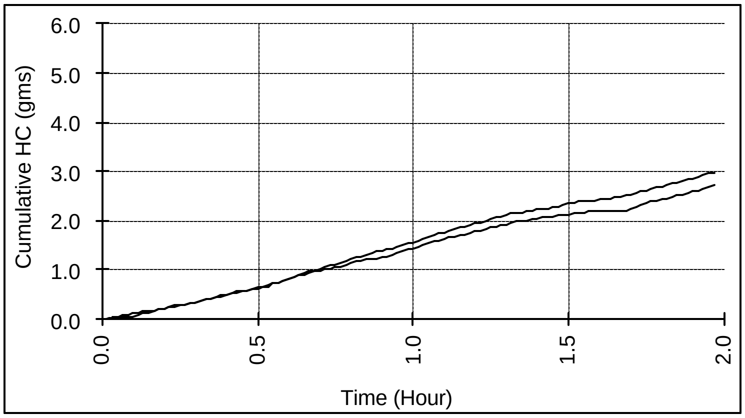
Baseline

Test#: 3495
Length: 24 hrs.
Temp: 72-96
Date: 7/20/00

Grams: 19.49

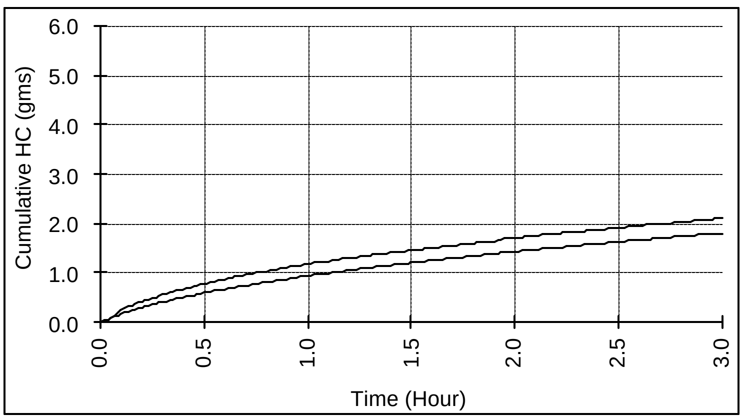
Figure 3 - Vehicle 03 Results
Vehicle: ARBHD03 (LHDGT): 1997 Chrysler 3500, 5.9L, PFI, 35 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST



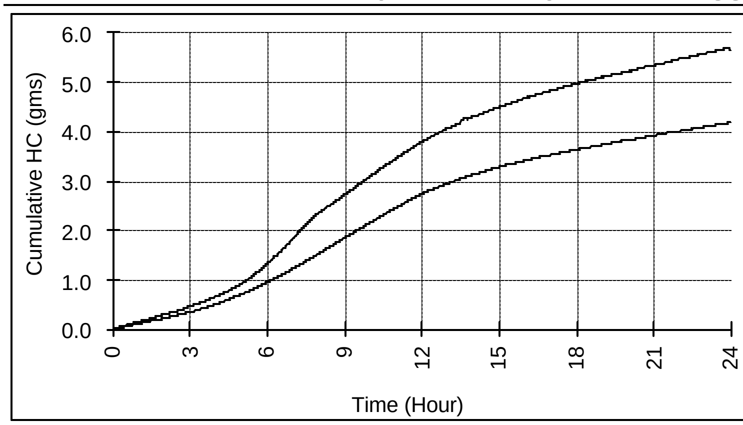
	Baseline	Replicate
Test#:	22331	22437
Length:	118 min.	118 min
Temp:	95°	95°
Date:	11/08/99	11/30/99
Dist:	29.78	29.79
Grams:	2.71	2.97
Gms/mile	0.091	0.100

HOT SOAK EVAPORATIVE EMISSIONS TEST



	Baseline	Replicate
Test#:	3266	3287
Length:	3 hrs.	3 hrs.
Temp:	95°	95°
Date:	11/08/99	11/30/99
Grams:	1.81	2.10

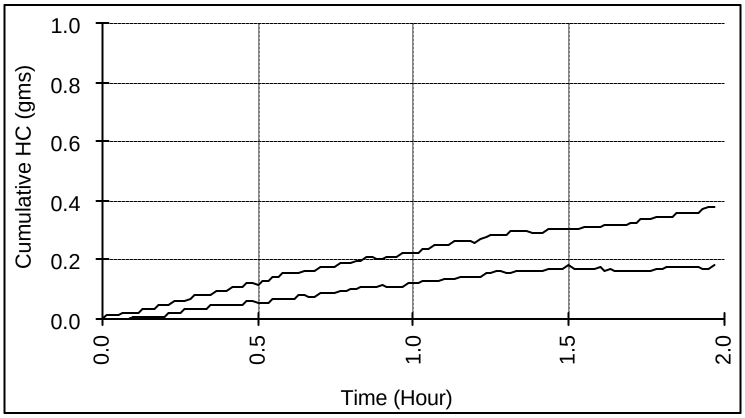
DIURNAL EVAPORATIVE EMISSIONS TEST



	Baseline	Replicate
Test#:	3269	3290
Length:	24 hrs.	24 hrs.
Temp:	72-96	72-96
Date:	11/09/99	12/01/99
Grams:	5.65	4.19

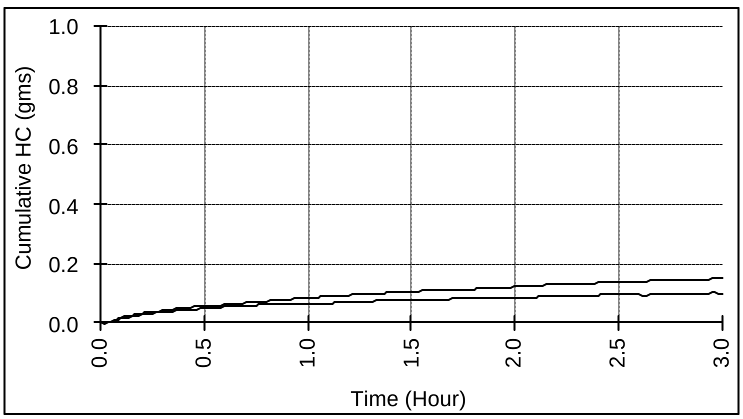
Figure 4 - Vehicle 04 Results
Vehicle: ARBHD04 (LHDGT): 1999 Chevrolet 3500 Van, 7.4L, PFI, 31 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST



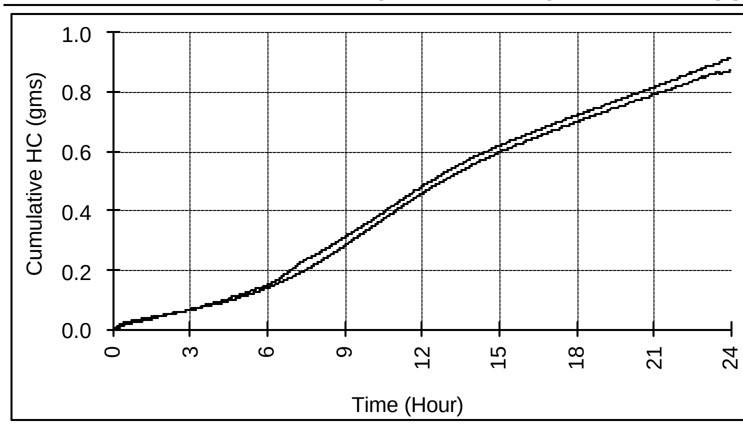
	Baseline	75°
Test#:	22353	22448
Length:	118 min.	118 min
Temp:	95°	75°
Date:	11/11/99	12/01/99
Dist:	29.77	29.81
Grams:	0.38	0.18
Gms/mile	0.013	0.006

HOT SOAK EVAPORATIVE EMISSIONS TEST



	Baseline	75°
Test#:	3272	3291
Length:	3 hrs.	3 hrs.
Temp:	95°	75°
Date:	11/11/99	12/01/99
Grams:	0.15	0.10

DIURNAL EVAPORATIVE EMISSIONS TEST



	Baseline	72-96
Test#:	3274	3292
Length:	24 hrs.	24 hrs.
Temp:	72-96	72-96
Date:	11/12/99	12/03/99
Grams:	0.92	0.87

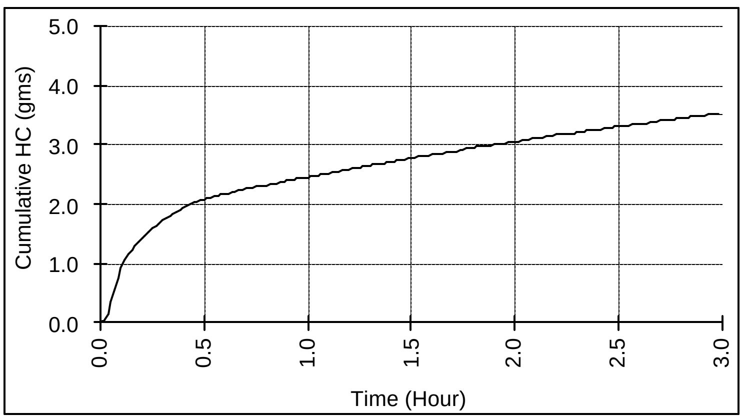
Figure 5 - Vehicle 05 Results
Vehicle: ARBHD05 (MHDGT): 1990 Ford Superduty, 7.5L, PFI, 19+19 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

Baseline

NA

HOT SOAK EVAPORATIVE EMISSIONS TEST

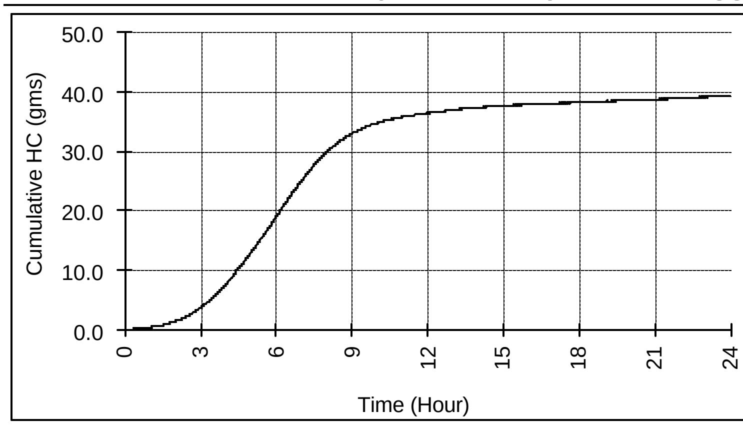


Baseline

Test#: 3542
Length: 3 hrs.
Temp: 95°
Date: 9/19/00

Grams: 3.52

DIURNAL EVAPORATIVE EMISSIONS TEST



Baseline

Test#: 3544
Length: 24 hrs.
Temp: 72-96
Date: 9/20/00

Grams: 39.37

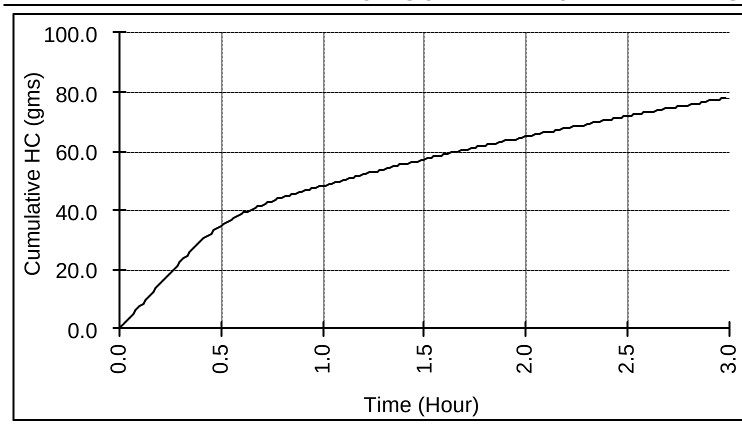
Figure 6 - Vehicle 06 Results
Vehicle: ARBHD06 (MHDGT): 1974 GMC 6500, 7.0L, Carb, 50+50 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

Baseline

NA

HOT SOAK EVAPORATIVE EMISSIONS TEST

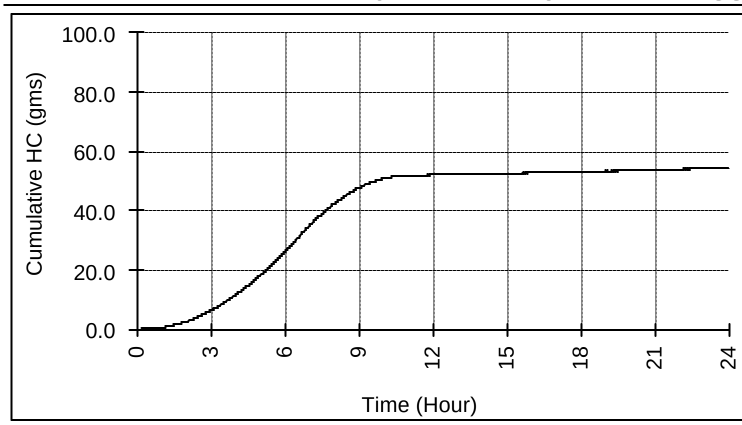


Baseline

Test#: 3570
Length: 3 hrs.
Temp: 95°
Date: 10/03/00

Grams: 78.08

DIURNAL EVAPORATIVE EMISSIONS TEST



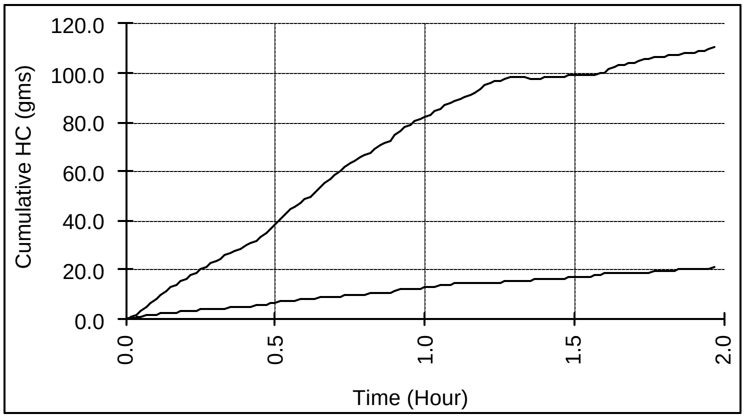
Baseline

Test#: 3571
Length: 24 hrs.
Temp: 72-96
Date: 10/04/00

Grams: 54.54

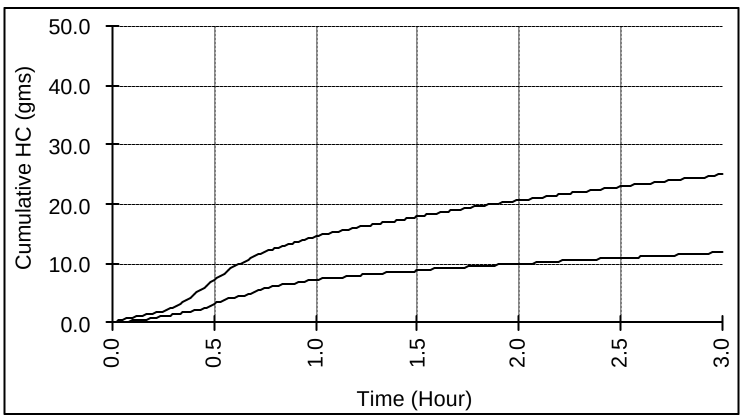
Figure 7 - Vehicle 07 Results
Vehicle: ABRHD07 (LHDGT): 1974 Ford F350, 6.4L, Carb, 18+20 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST



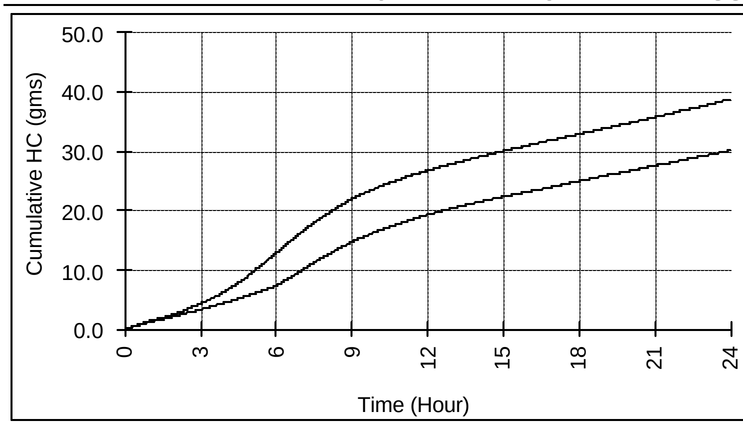
	Baseline	After Repair
Test#:	24599	24629
Length:	118 min.	118 min
Temp:	95°	95°
Date:	7/02/01	7/17/02
Dist:	29.84	29.54
Grams:	110.39	20.67
Gms/mile	3.70	0.70

HOT SOAK EVAPORATIVE EMISSIONS TEST



	Baseline	After Repair
Test#:	3848	3882
Length:	3 hrs.	3 hrs.
Temp:	95°	95°
Date:	7/02/01	7/17/01
Grams:	24.97	11.82

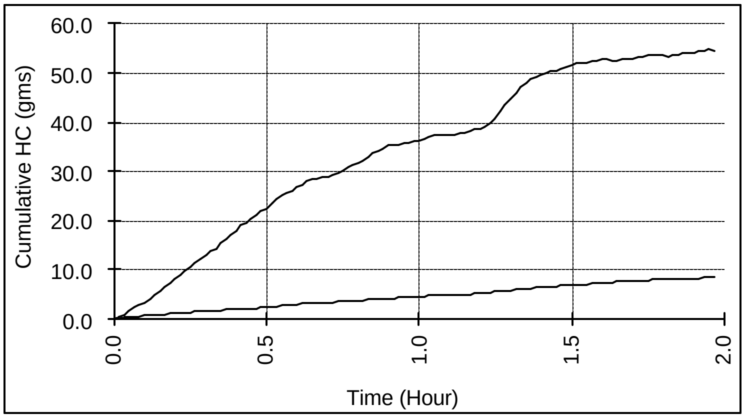
DIURNAL EVAPORATIVE EMISSIONS TEST



	Baseline	After Repair
Test#:	3851	3884
Length:	24 hrs.	24 hrs.
Temp:	72-96	72-96
Date:	7/03/01	7/18/01
Grams:	38.76	30.11

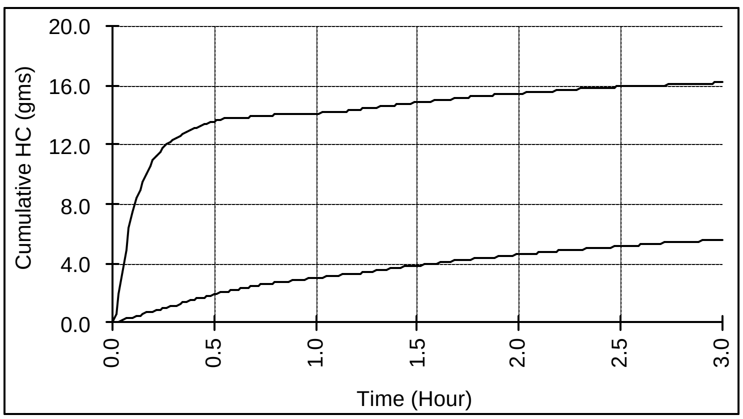
Figure 8 - Vehicle 08 Results
Vehicle: ABRHD08 (LHDGT): 1984 Chevrolet, 5.7L, Carb, 20+20 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST



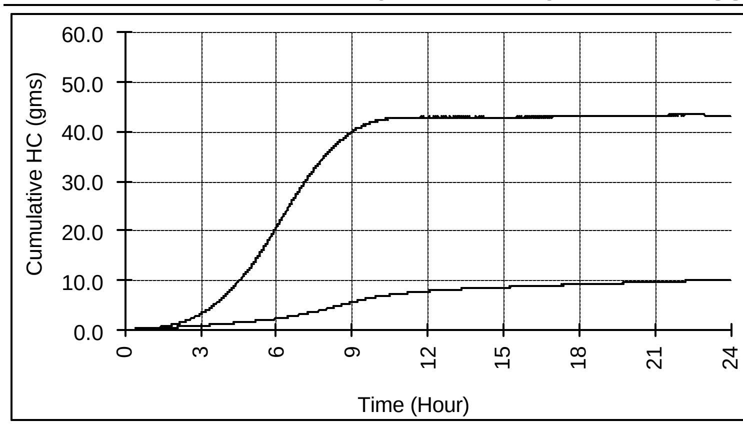
	Baseline	After Repair
Test#:	24591	24634
Length:	118 min.	118 min
Temp:	95°	95°
Date:	6/29/01	7/18/01
Dist:	29.81	29.60
Grams:	54.59	8.69
Gms/mile	1.83	0.29

HOT SOAK EVAPORATIVE EMISSIONS TEST



	Baseline	After Repair
Test#:	3841	3887
Length:	3 hrs.	3 hrs.
Temp:	95°	95°
Date:	6/29/01	7/18/01
Grams:	16.18	5.60

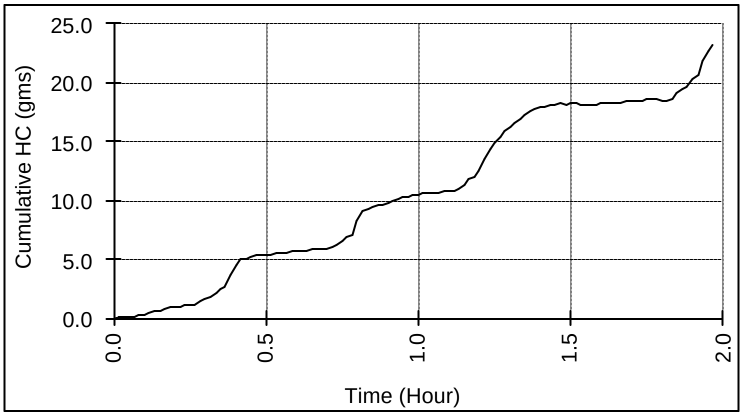
DIURNAL EVAPORATIVE EMISSIONS TEST



	Baseline	After Repair
Test#:	3843	3888
Length:	24 hrs.	24 hrs.
Temp:	72-96	72-96
Date:	6/30/01	7/19/01
Grams:	43.35	10.14

Figure 9 - Vehicle 09 Results
Vehicle: ARBHD09 (LHDGT): 1984 Dodge 3500 Van, 5.9L, Carb, 22 gal

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

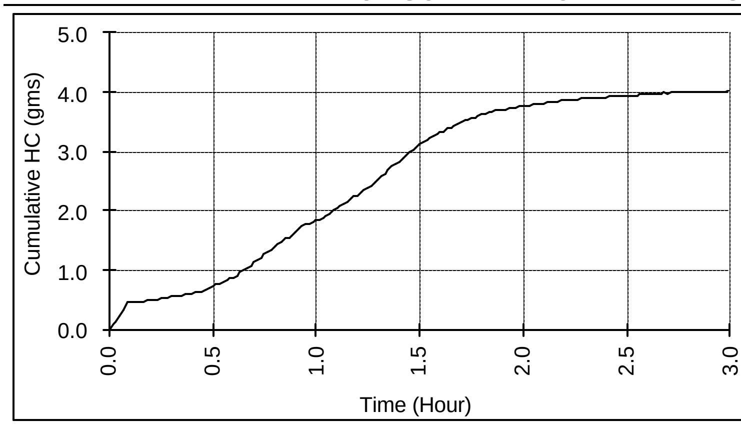


Baseline

Test#: 24686
Length: 118 min.
Temp: 95°
Date: 8/07/01
Dist: 29.91

Grams: 23.23
Gms/mile 0.78

HOT SOAK EVAPORATIVE EMISSIONS TEST

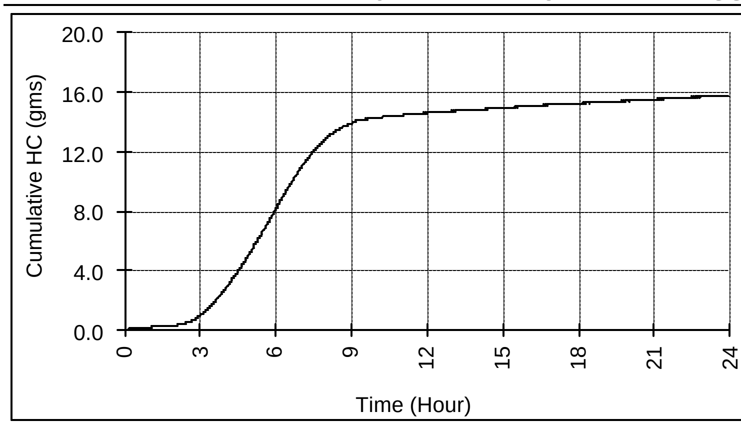


Baseline

Test#: 3937
Length: 3 hrs.
Temp: 95°
Date: 8/07/01

Grams: 4.02

DIURNAL EVAPORATIVE EMISSIONS TEST



Baseline

Test#: 3939
Length: 24 hrs.
Temp: 72-96
Date: 8/08/01

Grams: 15.81

C. Inspection Narrative

Each vehicle was subjected to a rigorous inspection following completion of baseline testing. In this section the results of these inspections are summarized. No repairs or actions that could change the as-received emissions were performed on any vehicle prior to the base line test. The incoming test was intended to represent actual in-use conditions for each vehicle.

ARBHDT01

This vehicle was a 1989 Ford F350 XLT outfitted as a flat bed truck. It was equipped with two fuel tanks. It had a 460 cid engine equipped with port fuel injection and feed back fuel control. Inspection did not reveal any gross failures or leaks. All evaporative emission components were present and intact. It would not hold pressure for the fuel tank leak check and it was missing the oil dipstick. The odometer on the vehicle was 189,764 miles. It showed indications of aging and use typical for a "working" vehicle of this type.

The exhaust pipe passed on the opposite side of the driveshaft from the center fuel tank. After passing over the rear axle, it passed within 5 inches of the rear fuel tank. The high bed provided very good ventilation around the fuel tanks, which had only a 27°F temperature rise after 2 hours of operation.

Results of the testing were reasonable for a 10+ year old vehicle.

ARBHDT02

This vehicle was a 1990 Ford F250XL configured as a full size pickup. It was equipped with two fuel tanks. It had a 351 cid engine with port fuel injection. All evaporative emission components were present and intact. It failed the pressure check. The as-received odometer on this vehicle was 118,603 miles. It was a full size pickup. No signs of damage repair or rebuilds were found. The vehicle appeared to have been used more for transportation than hauling heavy materials, with wear typical of a non-commercial vehicle of this vintage.

The exhaust pipe passed opposite the mid ship fuel tank, but passed within 4 inches of the rear fuel tank. Sheet metal enclosed the rear of the truck. The tank had a 32°F rise after two hours of road operation, creating higher running losses. The dual fuel tanks were slightly larger than vehicle 01, also promoting higher evaporative emissions. Results were higher than truck 01, but within the range expected for a vehicle of this age.

ARBHDT03

This vehicle was a 1997 Chrysler Ram 3500 15 passenger van. It was equipped with a single 35 gallon tank at the rear of the vehicle. It passed the evaporative control system purge and pressure checks. All components were present and intact. The as-received odometer was 48,475 miles. This vehicle was tested in November of 1999. It's rate of mileage accumulation was higher than typical for a private vehicle, but the overall condition was good.

The exhaust pipe of this vehicle passed within 3 inches of one side of the fuel tank. A heat shield separated the tank from the pipe. The fuel temperature rose 25°F during operation on the test track. The vehicle was not required to pass the enhanced running loss and 24 hour diurnal test. Results were higher than acceptable for a light-duty vehicle of this vintage, but not unusual for a modern technology vehicle certified before implementation of enhanced evaporative emission standards.

ARBHDT04

This vehicle was a 1999 Chevrolet 3500 15 passenger van. It was equipped with a single 31-gallon fuel tank mounted mid ship on the left side. It passed the evaporative control system purge and pressure checks. All components were present and intact. This was a 1999 vehicle tested in October of 1999. It's as-received odometer was 18,584 miles. No unusual wear or damage was noted during inspection.

The exhaust pipe of this vehicle passed on the opposite side of the drive shaft from the tank. The fuel temperature rise observed during track operation was 29°F. This 9500 GVWR vehicle met the standards for running losses and hot soak + diurnal specified for a light-duty vehicle. It was the newest vehicle tested. The canister and associated controls were adequately sized and appeared similar in design that observed on light-duty vehicles. It was equipped for OBDII evaporative system verification. This vehicle demonstrates that it is possible to achieve the more stringent enhanced emission standards even at higher loads and tank capacity.

ARBHDT05

This vehicle was a 1990 Ford Superduty Medium Heavy-Duty truck. It was equipped with a 460 cid port fuel injected engine. It was equipped to move over-the-road trailers. It had (2) nineteen gallon tanks, one mid ship and the second at the rear. The vehicle failed the pressure test. The rubber components showed signs of aging. No repairs were performed prior to the as-received test. Following completion of the baseline test, the filler neck hoses, the gas caps, the front filler neck, and rubber grommets in the tanks were replaced to achieve a seal. The vehicle passed the pressure and purge test when returned to its owner. It had 87,302 miles on the odometer when the inspection was performed.

The exhaust pipe of this vehicle was on the opposite side of the mid ship tank. The pipe passed within 3 inches of a heat shield installed between the pipe and the rear tank. The tanks were well exposed to air movement. No fuel temperature or running loss tests were performed on the medium heavy-duty class vehicles.

The overall condition of this vehicle was poor. All rubber and plastic components were aged and cracked.

ARBHDT06

This vehicle was a 1974 GMC 6500 dump truck. It was equipped with a 427 cid carbureted engine. It was equipped with (2) fifty gallon tanks. Multiple failures and liquid leaks were discovered during inspection. The carburetor leaked fuel around the accelerator pump. The canister purge nipple was broken off. The carburetor was not the original application. The fuel pump was leaking. The purge vacuum line was missing. The driver's side tank would not hold pressure. The passenger fuel tank cap was missing its gasket. This was an old truck that showed its age. Evaporative emission results obtained reflected the condition of the vehicle. Significant cost and efforts would be required to restore the vehicle. Complete restoration would not be expected to cause the vehicle to pass enhanced testing protocols. No corrections were made prior to the as-received test. The vehicle odometer displayed 61,354, but the condition of the vehicle indicated at least 161,354 if not 261,354 miles.

ARBHDT07

This vehicle was a 1974 Ford F350 custom with a flat bed. It was equipped with a 390 cid carbureted engine and two fuel tanks. One fuel tank was mounted behind the seat in the passenger compartment. A second tank was mounted mid ship. The interior tank marginally passed the pressure test. The mid ship tank failed. Both gas caps failed. The mid ship filler neck bracket was incorrectly installed, causing interference with the cap seal. The fuel pump and carburetor accelerator pumps were leaking fuel. The purge hose was broken off. The vacuum lines were misrouted. No repairs were performed prior to the as-received test. The vehicle odometer displayed 243,446 miles during inspection.

This was also an older truck. An attempt to repair all liquid fuel leaks and to restore the vacuum hose routing was made. The fuel pump was replaced. The carburetor was rebuilt. Vacuum lines and tees were correctly routed. The filler neck was correctly installed. The gas caps were replaced. Following completion of repairs the vehicle passed the pressure and purge tests. A retest resulted in an 80% reduction in running losses and a 50% reduction in hot soak emissions. These reductions were primarily the result of eliminating the liquid fuel leaks. The final results were still much higher than observed with newer vehicles, but typical of vehicles equipped with evaporative systems of this vintage. The diurnal emissions were reduced approximately 20%, a result of the large fuel tank capacity and inadequate vapor storage capacity for a 24 hour diurnal test.

ARBHDT08

This vehicle was a 1984 GM CB dump truck. It is equipped with (2) twenty-gallon fuel tanks. It has a 350 cid carbureted engine. Liquid fuel was detected at the fuel tank switching valve and all hoses leading into and out of the switching valve. The vacuum control lines were misrouted for both the evaporative and EGR exhaust emission control systems. The canister bowl vent control valve was damaged. The driver's side gas cap failed the leak check. No repairs were performed prior to the as-received test. The vehicle odometer reflected 150,988 miles.

Attempts to repair this vehicle were also made with the exception of the canister bowl vent valve function. This repair would require replacement of the canister. All liquid fuel leaks were repaired and the hose routing was repair and restored.

These repairs resulted in an 85% reduction in running losses and an 80% reduction in first hour hot soak emissions, again primarily by elimination of the liquid fuel leaks. A 75% reduction in diurnal emissions was measured. The emission levels observed following the repairs were in line with results observed on other vehicles of this vintage and fuel tank capacity.

ARBHDT09

This vehicle was a 1984 Dodge B350 van. It was equipped with a 360 cid carbureted engine. It had one 22 gallon fuel tank mounted in the rear of the vehicle. The vehicle passed the purge test but failed the pressure test. No attempt to repair the vehicle was made. No repairs were performed prior to the as-received test. The vehicle odometer reflected 126,102 miles. The current owner used the vehicle for transporting day laborers to different work sites. It appeared to have been originally delivered as a military vehicle, as indicated by an identification plate mounted on the dashboard.

The exhaust pipe on this vehicle passed within 2 inches of the rear mounted fuel tank. The fuel tank temperature rise noted during road operation was 23°F, typical of a carbureted engine of this vintage. Evaporative results were not out of line for a vehicle of this age and fuel tank carrying capacity.

D. Fuel Inspection Results

The fuel used for tests in this program were from a batch of commercial California Phase II that was captured in barrels and transported to ATL's Mesa Arizona site. Barrels were refrigerated until used. Samples were collected and sent for independent analysis with the following results:

Table 4.
Fuel Inspection Results

	Specification	07/13/1999	09/28/2000
Distillation			
IBP	report	97	87
10%	130-150	136	132
50%	190-210	195	204
90%	290-300	314	315
EP	390 max	412	417
FIA			
Saturates	remain	72.9	72.2
Olefins	4.0-5.0	3.7	3.0
Aromatics	22-25	23.4	24.8
RVP			
Grabner	6.7-7.0	6.95	7.32
Dry	6.7-7.0	-	7.50
MTBE	10.8-11.2	11.7	6.9
Benzene	0.8-1.0	-	0.6
Sulfur (ppm)	30-40	20	-

IV. Summary, Conclusions, and Recommendations

Historically, emission factors for heavy-duty gasoline powered vehicles have been estimated by extrapolation from light-duty truck results. A very substantial body of results is available from the light-duty class of vehicle. The Coordinating Research Council (CRC) sponsored extensive testing of in-use vehicles using modern evaporative emission testing protocols in the late 1990's. Both ARB and the USEPA perform ongoing in-use vehicle testing programs. Certification results provided by vehicle manufacturers provide additional data.

Limited actual data with larger vehicles has been collected, particularly with current enhanced evaporative testing procedures. This project was intended to collect a limited amount of such data, not to serve as a basis for statistical estimation of evaporative emission factors for the entire in-use fleet, but to provide an initial sample. Results are to be examined by EMFAC 2001 modelers to determine if past estimates and extrapolations have been reasonable, and to assist in development of appropriate factors for this class of vehicle.

Results obtained during the program were consistent with the results from smaller light-duty vehicles, taking into account such factors as fuel capacity, age, maintenance, and certification standards applied to the specific vehicle.

Substantial reductions in in-use emissions can be achieved through comprehensive inspection and maintenance of older vehicles. Liquid fuel leaks can be found on many vehicles of 1990 and earlier vintage. This finding corresponds to observations made on a multitude of light-duty vehicle. Time will have to pass to determine if the improved materials required to pass enhanced evaporative emission standards will prove more durable than those used through the early 1990's, for both the light and heavy-duty fleet.

In summary, this program provides additional confidence to the practice of extrapolating light-duty vehicle evaporative emissions results to the gasoline powered heavy-duty truck class.

Acronyms

ATL	Automotive Testing Laboratories, Inc.
cid	Cubic Inch Displacement
GVWR	Gross Vehicle Weight Rating
HDGT	Heavy-Duty Gasoline Powered Truck
HHDGT	Heavy Heavy-Duty Gasoline Powered Truck
LHDGT	Light Heavy-Duty Gasoline Powered Truck
MHDGT	Medium Heavy-Duty Gasoline Powered Truck
UDDS	Urban Driving Dynamometer Schedule
VT-SHED	Variable Temperature - Sealed Housing for Evaporative Determination

Appendix 1

Vehicle Identification Data

Veh #	MY	Make	Model	Cert type	Engine Family	Evap. Family	VIN
ARBHD01	1989	Ford	F350 XLT	LHDGT	KFM07.5BTAX	9HN	1FTJX35G5KKB48790
ARBHD02	1990	Ford	F250 XL	LHDGT	LFM05.8BSA7	DHA	2FTHF26H1LCA58237
ARBHD03	1997	Chrysler	3500 Ram Van	LHDGT	VCR360J8G1EL	VCR1073AYPOB	2B5WB35Z7VK591701
ARBHD04	1999	Chevrolet	3500 Van	LHDGT	XGMXA07.4201	XGMXE0111909	1GAHG39J2X1086839
ARBHD05	1990	Ford	F-Superduty	MHDGT	LFM07.5BSB8	9HN	2FOLF47G4LCA13946
ARBHD06	1974	GMC	6500	MHDGT	no sticker	no sticker	TCE664V608312
ARBHD07	1974	Ford	F350 Custom	LHDGT	360-390	661	F37HRT68856
ARBHD08	1984	Chevrolet	CB	LHDGT	EGM05.7AGB7	XHH	1GBJC34M1EV141376
ARBHD09	1984	Chrysler	Dodge Van	LHDGT	ECC05.9ARB8	Not Listed	2B5WB3117ER249312

Appendix 2

Vehicle Specifications

Veh Num	MY	Make	Eng	Fuel	GVW	Class	Tank Type	Tank Size	Tank Size	Trans	Build Date	Supp Air	Cat
ARBHD01	1989	Ford	7.5	PFI	10,000	LHDGT	Steel	15.0	23.0	Auto	5/89	Pump	Yes
ARBHD02	1990	Ford	5.8	PFI	8,600	LHDGT	Steel	18.0	25.5	Auto	1/90	Pump	Yes
ARBHD03	1997	Chrys	5.9	PFI	9,000	LHDGT	Plast	35.0	-	Auto	6/97	no	Yes
ARBHD04	1999	Chev	7.4	PFI	9,500	LHDGT	Steel	31.0	-	Auto	1/99	Pump	Yes
ARBHD05	1990	Ford	7.5	PFI	14,500	MHDGT	Steel	19.0	19.0	Man	9/89	Pump	Yes
ARBHD06	1974	GMC	7.0	Carb	24,000	MHDGT	Steel	50.0	50.0	Man	8/74	no	no
ARBHD07	1974	Ford	6.4	Carb	10,000	LHDGT	steel	18.0	20.0	Auto	11/73	no	no
ARBHD08	1984	Chev	5.7	Carb	10,500	LHDGT	steel	20.0	20.0	Auto	7/84	Pump	no
ARBHD09	1984	Dodge	5.9	Carb	8,510	LHDGT	Steel	22.0	-	Auto	12/83	Pump	Yes

Appendix 3

Results Summary

Veh #	Yr./Make/Model	Running Loss Grams	Running Loss Gram/mi	Cumulative Hot Soak Hr 1 Grams	Cumulative Hot Soak Hr 2 Grams	Cumulative Hot Soak Hr 3 Grams	24-hour DHB Grams	
ARBHD01	1989 Ford F350	8.72	0.29	1.02	1.17	1.30	9.05	Baseline
LHDGT	7.5L, PFI, 15+23 gal							
ARBHD02	1990 Ford F250	30.64	1.02	0.41	0.57	0.69	19.49	Baseline
LHDGT	5.7L, PFI, 23+19 gal							
ARBHD03	1997 Chrysler 3500	2.71	0.091	0.93	1.43	1.81	5.65	Baseline
LHDGT	5.9L, PFI, 35 gal	2.97	0.100	1.17	1.71	2.10	4.19	Replicate
ARBHD04	1999 Chev 3500 Van	0.38	0.013	0.09	0.12	0.15	0.92	Baseline
LHDGT	7.4L, PFI, 31 gal	0.18	0.006	0.06	0.09	0.10	0.87	75°
ARBHD05	1990 Ford Superduty	-	-	2.44	3.05	3.52	39.37	Baseline
MHDGT	7.5L, PFI, 19+19 gal							
ARBHD06	1974 GMC 6500	-	-	48.34	64.88	78.08	54.54	Baseline
MHDGT	7.0L, Carb, 50+50 gal							
ARBHD07	1974 Ford F350	110.39	3.70	14.46	20.64	24.97	38.76	Baseline
LHDGT	6.4L, Carb, 18+20 gal	20.67	0.70	7.28	9.93	11.82	30.11	After Repair
ARBHD08	1984 Chev	54.59	1.83	14.11	15.45	16.18	43.35	Baseline
LHDGT	5.7L, Carb, 20+20 gal	8.69	0.29	3.01	4.58	5.60	10.14	After Repair
ARBHD09	1984 Dodge 3500 Van	23.23	0.78	1.83	3.77	4.02	15.81	Baseline
LHDGT	5.9L, Carb, 22 gal							

Test: Sequence Summary
Vehicle: 001
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG		
								Test#	23192
								Date	6/01/00
LA4 1			3.284	29.73	6.437	998	8.45	Time	9:34
Bag	2.990	0.181	3.173	34.24	5.429	986	8.50	Temp:	95°
2 min Idle grams			0.524	0.00	0.702	274		Odom.	89908
LA4 2			1.824	6.93	7.964	1010	8.69	I.W.	6000
Bag	1.574	0.183	1.759	6.78	6.843	1009	8.71	AHP:	17.6
2 min Idle grams			0.568	0.03	0.645	272			
LA4 3			1.614	5.91	7.996	1009	8.72		
Bag	1.379	0.182	1.563	5.81	6.829	1004	8.76		
LA4 4			2.229	7.51	8.422	990	8.84		
Bag	2.044	0.168	2.213	7.90	7.692	1016	8.62		
2 min Idle grams			1.760	0.01	0.214	227			

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell FID R	Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms		
										Test#	23192
										Date	6/01/00
										Time	9:37
	---	------	-------	-------	-------	-------	-------	-------	-------	Temp.	95°
Initial	3	4.2	4.2	96.2	95.3	94.6	----	0.00	0.00	Shed Vol:	7973.5
LA4 1	3	20.2	20.2	97.7	110.7	109.4	7.44	1.93	1.93	Distance:	29.71
2min Idle	3	20.7	20.7	97.9	111.1	110.6	----	0.06	1.99	Barom.	28.57
LA4 2	3	37.1	37.1	97.7	120.5	120.1	7.42	1.98	3.96	Odom.	89908
2min Idle	3	37.5	37.5	98.8	119.5	118.6	----	0.04	4.00	I.W.	6000
LA4 3	3	52.9	52.9	100.1	122.7	125.2	7.43	1.84	5.84	AHP:	17.6
Soak	3	53.4	53.3	96.9	116.0	114.6	----	0.10	5.93		
LA4 4	3	74.1	74.0	96.3	121.3	123.0	7.41	2.51	8.44		
2min Idle	3	76.1	76.0	94.1	123.0	122.3	----	0.28	8.72	Gms/mile =	0.29

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms		
								Test#	3477
								Date	6/01/00
	---	------	-------	----	-------	-------	-------	Time	11:42
Initial	4	4.7	14.2	87.6	28.66	0.00	0.00	Temp.	95°
Hour 1	4	15.5	46.8	95.2	28.63	1.02	1.02	SHED:	16
Hour 2	4	17.1	51.6	95.0	28.60	0.15	1.17	RL to HLS	0:07
Hour 3	4	18.5	55.8	95.2	28.57	0.13	1.30		
								Grams=	1.30

DIURNAL EVAPORATIVE EMISSIONS TEST

	R	Shed 13 Defl	ppm	Avg Temp	Baro	Net Gms	Cum Gms		
								Test#	3479
								Date	6/02/00
								Time	13:19
	---	------	-------	-------	-------	-------	-------	Temp.	72°-96°
Initial	3	8.0	8.0	71.2	28.71	0.00	0.00	Bag Vol (in liters):	4400
Hour 24	5	30.3	304.2	71.1	28.70	9.05	9.05	SHED:	13
								Soak Time:	22:37
								Grams=	9.05

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 002
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG
LA4 1			2.123	12.67	2.993	856	10.11
Bag	2.346	0.316	2.665	14.65	4.019	857	10.04
2 min Idle grams			0.133	0.00	0.196	209	
LA4 2			0.482	1.03	2.711	838	10.61
Bag	0.285	0.207	0.494	1.27	3.744	848	10.47
2 min Idle grams			0.137	0.00	0.197	215	
LA4 3			0.520	2.16	2.666	843	10.52
Bag	0.330	0.196	0.528	2.21	3.759	851	10.43
LA4 4			0.583	2.11	3.002	852	10.41
Bag	0.464	0.192	0.658	2.50	4.243	860	10.31
2 min Idle grams			0.304	0.00	0.201	220	

Test# 23453
Date 7/19/00
Time 12:10
Temp: 95°
Odom. 118853
I.W. 6000
AHP: 17.5

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms
	---	------	-------	-------	-------	-------	-------	-------	-------
Initial	4	17.5	52.4	94.3	96.1	95.0	----	0.00	0.00
LA4 1	4	37.1	111.2	96.4	109.8	108.8	7.51	7.07	7.07
2min Idle	4	38.2	114.5	97.3	110.7	109.1	----	0.38	7.45
LA4 2	4	63.4	190.0	94.9	120.1	118.9	7.45	9.21	16.65
2min Idle	4	64.4	193.0	95.5	120.1	118.1	----	0.34	16.99
LA4 3	5	25.9	258.9	96.4	125.8	125.7	7.45	7.93	24.92
Soak	5	27.3	272.9	95.9	122.3	122.3	----	1.72	26.64
LA4 4	5	30.3	302.9	95.7	126.9	127.5	7.48	3.64	30.28
2min Idle	5	30.5	304.9	93.9	128.7	127.3	----	0.36	30.64

Test# 23453
Date 7/19/00
Time 12:10
Temp. 95°
Shed Vol: 7973.5
Distance: 29.90
Barom. 28.56
Odom. 118853
I.W. 6000
AHP: 17.5

Gms/mile = 1.02

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms
	---	------	-------	----	-------	-------	-------
Initial	4	10.4	31.4	96.9	28.35	0.00	0.00
Hour 1	4	14.8	44.7	95.5	28.29	0.41	0.41
Hour 2	4	16.4	49.5	94.0	28.24	0.15	0.57
Hour 3	4	17.8	53.7	95.2	28.20	0.13	0.69

Test# 3494
Date 7/19/00
Time 14:14
Temp. 95°
SHED: 16
RL to HLS 0:06

Grams= 0.69

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms
	------	-------	-------	-------	-------	-------
Initial	4.4	6.8	72.5	28.60	0.00	0.00
Hour 24	5.4	257.9	72.9	28.63	19.49	19.49

Test# 3495
Date 7/20/00
Time 8:50
Temp. 72°-96°
Bag Vol (in liters): 0
SHED: 11
Soak Time: 15:36

Grams= 19.49

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 003 - AS RECEIVED
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG		
								Test#	22331
LA4 1			0.235	3.78	0.498	756	11.70	Date	11/08/99
Bag	0.193	0.044	0.238	3.87	0.426	748	11.82	Time	9:36
2 min Idle grams			0.021	0.00	0.050	190		Temp:	95°
LA4 2			0.056	0.84	0.216	713	12.48	Odom.	48646
Bag	0.029	0.031	0.060	0.84	0.193	711	12.52	I.W.	5500
2 min Idle grams			0.022	0.01	0.056	188		AHP:	18.4
LA4 3			0.052	0.77	0.185	709	12.56		
Bag	0.028	0.030	0.058	0.79	0.160	708	12.59		
LA4 4			0.068	0.90	0.487	730	12.19		
Bag	0.036	0.035	0.071	0.92	0.430	723	12.31		
2 min Idle grams			0.024	0.00	0.036	195			

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms		
	---	------	-------	-------	-------	-------	-------	-------	-------	Test#	22331
Initial	3	5.1	5.1	95.2	95.3	95.0	----	0.00	0.00	Date	11/08/99
LA4 1	3	9.0	9.0	96.3	101.8	102.6	7.43	0.47	0.47	Time	9:36
2min Idle	3	9.4	9.4	96.3	102.7	103.2	----	0.05	0.52	Temp.	95°
LA4 2	3	14.5	14.5	97.5	109.9	110.3	7.45	0.62	1.14	Shed Vol:	7973.5
2min Idle	3	14.9	14.9	96.2	110.7	110.7	----	0.05	1.19	Distance:	29.78
LA4 3	3	20.0	20.0	97.0	116.0	116.6	7.44	0.62	1.81	Barom.	28.75
Soak	3	22.9	22.9	94.6	116.3	116.8	----	0.36	2.17	Odom.	48646
LA4 4	3	26.9	26.9	97.0	119.5	120.3	7.46	0.47	2.64	I.W.	5500
2min Idle	3	27.4	27.4	96.4	120.0	120.6	----	0.06	2.71	AHP:	18.4

Gms/mile = 0.09

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms		
	---	------	-------	----	-------	-------	-------	Test#	3266
Initial	3	6.5	6.5	96.3	28.87	0.00	0.00	Date	11/08/99
Hour 1	3	35.8	36.0	95.2	28.79	0.93	0.93	Time	11:35
Hour 2	3	51.4	51.6	95.1	28.73	0.49	1.43	Temp.	95°
Hour 3	3	63.4	63.7	95.2	28.68	0.38	1.81	SHED:	16
								RL to HLS	0:01

Grams= 1.81

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms		
	------	-------	-------	-------	-------	-------	Test#	3269
Initial	5.1	16.8	72.6	28.76	0.00	0.00	Date	11/09/99
Hour 24	4.7	98.2	72.6	28.78	5.65	5.65	Time	9:30
							Temp.	72°-96°
							Bag Vol (in liters):	Hybrid
							SHED:	11
							Soak Time:	18:55

Grams= 5.65

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 003 - REPLICATE
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG		
								Test#	22437
								Date	11/30/99
LA4 1			0.201	2.84	0.381	712	12.45	Time	9:14
Bag	0.174	0.037	0.211	3.11	0.321	696	12.71	Temp:	95°
2 min Idle grams			0.018	0.02	0.052	178		Odom.	48690
LA4 2			0.055	0.92	0.241	729	12.21	I.W.	5500
Bag	0.038	0.028	0.066	0.95	0.194	720	12.37	AHP:	18.4
2 min Idle grams			0.016	0.02	0.072	190			
LA4 3			0.041	0.73	0.250	704	12.65		
Bag	0.027	0.027	0.054	0.73	0.193	697	12.77		
LA4 4			0.066	0.83	4.909	715	12.45		
Bag	0.035	0.030	0.066	0.81	0.324	705	12.63		
2 min Idle grams			0.024	0.03	0.695	192			

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms		
										Test#	22437
										Date	11/30/99
										Time	9:14
	---	------	-------	-------	-------	-------	-------	-------	-------	Temp.	95°
Initial	3	6.7	6.7	95.1	95.0	95.0	----	0.00	0.00	Shed Vol:	7973.5
LA4 1	3	10.5	10.5	97.2	100.6	102.6	7.45	0.46	0.46	Distance:	29.79
2min Idle	3	10.9	10.9	96.8	101.5	103.2	----	0.05	0.51	Barom.	28.93
LA4 2	3	16.7	16.7	98.1	110.5	110.3	7.44	0.70	1.21	Odom.	48690
2min Idle	3	17.2	17.2	97.2	111.3	110.7	----	0.06	1.28	I.W.	5500
LA4 3	3	22.9	22.9	98.3	116.6	116.6	7.45	0.69	1.97	AHP:	18.4
Soak	3	26.2	26.2	94.1	116.7	116.8	----	0.43	2.40		
LA4 4	3	30.7	30.7	97.9	120.6	120.3	7.45	0.53	2.92		
2min Idle	3	31.1	31.1	97.4	121.1	120.6	----	0.05	2.97	Gms/mile =	0.10

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms		
								Test#	3287
								Date	11/30/99
	---	------	-------	----	-------	-------	-------	Time	11:14
Initial	3	6.4	6.4	91.6	29.25	0.00	0.00	Temp.	95°
Hour 1	3	42.8	43.0	96.5	29.20	1.17	1.17	SHED:	16
Hour 2	3	59.5	59.8	95.7	29.09	0.53	1.71	RL to HLS	0:02
Hour 3	3	71.8	72.1	94.9	29.04	0.40	2.10		
								Grams=	2.10

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms		
							Test#	3290
							Date	12/01/99
							Time	10:35
	------	-------	-------	-------	-------	-------	Temp.	72°-96°
Initial	3.4	7.0	72.4	28.75	0.00	0.00	Bag Vol (in liters):	0
Hour 24	7.5	72.9	72.1	28.80	4.19	4.19	SHED:	11
							Soak Time:	20:21
							Grams=	4.19

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 004 - AS RECEIVED
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG		
								Test#	22353
								Date	11/11/99
LA4 1			0.344	3.92	1.171	895	9.88	Time	11:20
Bag	0.280	0.049	0.329	4.04	0.951	877	10.09	Temp:	95°
2 min Idle grams			0.015	0.07	0.010	190		Odom.	18788
LA4 2			0.058	1.44	0.488	856	10.40	I.W.	7000
Bag	0.029	0.027	0.057	1.81	0.442	843	10.55	AHP:	22.0
2 min Idle grams			0.013	0.03	0.010	191			
LA4 3			0.068	2.28	0.359	855	10.39		
Bag	0.038	0.031	0.070	3.18	0.340	845	10.50		
LA4 4			0.085	2.42	0.656	903	9.84		
Bag	0.047	0.041	0.088	3.10	0.591	887	10.00		
2 min Idle grams			0.061	0.09	0.006	168			

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms		
										Test#	22353
										Date	11/11/99
										Time	11:20
	---	------	-------	-------	-------	-------	-------	-------	-------	Temp.	95°
Initial	3	4.4	4.4	95.1	94.3	95.0	----	0.00	0.00	Shed Vol:	7973.5
LA4 1	3	5.2	5.2	98.0	105.1	104.6	7.47	0.09	0.09	Distance:	29.77
2min Idle	3	5.3	5.3	97.1	105.9	105.3	----	0.01	0.11	Barom.	28.78
LA4 2	3	6.0	6.0	97.0	113.4	113.7	7.46	0.09	0.19	Odom.	18788
2min Idle	3	6.0	6.0	94.5	114.2	113.9	----	0.00	0.20	I.W.	7000
LA4 3	3	6.7	6.7	100.2	119.7	120.1	7.43	0.08	0.27	AHP:	22.0
Soak	3	7.0	7.0	96.7	120.5	120.4	----	0.04	0.31		
LA4 4	3	7.5	7.5	98.4	122.6	124.3	7.42	0.06	0.37		
2min Idle	3	7.5	7.5	93.1	123.7	124.3	----	0.01	0.38	Gms/mile =	0.01

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms		
								Test#	3272
								Date	11/11/99
	---	------	-------	----	-------	-------	-------	Time	13:18
Initial	3	4.4	4.4	91.5	28.85	0.00	0.00	Temp.	95°
Hour 1	3	7.1	7.1	95.1	28.81	0.09	0.09	SHED:	16
Hour 2	3	8.3	8.3	95.8	28.79	0.04	0.12	RL to HLS	0:00
Hour 3	3	9.1	9.1	95.9	28.79	0.03	0.15		
								Grams=	0.15

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms		
							Test#	3274
							Date	11/12/99
							Time	9:25
	------	-------	-------	-------	-------	-------	Temp.	72°-96°
Initial	2.8	4.4	72.2	28.82	0.00	0.00	Bag Vol (in liters):	Hybrid
Hour 24	3.9	20.2	71.3	28.81	0.92	0.92	SHED:	11
							Soak Time:	17:07
							Grams=	0.92

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 004 - 75°F REPLICATE
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG
LA4 1			0.343	2.07	1.614	860	10.33
Bag	0.320	0.041	0.361	2.30	0.876	836	10.62
2 min Idle grams			0.000	0.04	0.035	212	
LA4 2			0.022	0.47	0.465	788	11.32
Bag	0.014	0.020	0.034	0.49	0.275	772	11.55
2 min Idle grams			0.011	0.03	0.034	211	
LA4 3			0.031	0.59	0.451	880	10.13
Bag	0.021	0.024	0.045	0.64	0.382	863	10.32
LA4 4			0.064	0.56	0.856	882	10.11
Bag	0.038	0.033	0.071	0.63	0.686	871	10.23
2 min Idle grams			0.005	0.01	0.000	209	

Test# 22448
Date 12/01/99
Time 12:44
Temp: 75°
Odom. 18826
I.W. 7000
AHP: 19.2

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms
	---	------	-------	-------	-------	-------	-------	-------	-------
Initial	3	6.1	6.1	75.7	75.3	75.0	----	0.00	0.00
LA4 1	3	6.5	6.5	77.2	84.5	84.6	7.46	0.05	0.05
2min Idle	3	6.5	6.5	76.3	85.3	85.3	----	0.00	0.05
LA4 2	3	7.0	7.0	83.6	93.9	93.7	7.45	0.05	0.10
2min Idle	3	7.0	7.0	80.8	94.6	93.9	----	0.00	0.10
LA4 3	3	7.4	7.4	90.3	100.7	100.1	7.45	0.03	0.14
Soak	3	7.4	7.4	73.0	99.7	100.4	----	0.03	0.17
LA4 4	3	7.6	7.6	86.5	103.9	104.3	7.45	0.00	0.17
2min Idle	3	7.7	7.7	87.3	103.5	104.3	----	0.01	0.18

Test# 22448
Date 12/01/99
Time 12:44
Temp. 75°
Shed Vol: 7973.5
Distance: 29.81
Barom. 28.67
Odom. 18826
I.W. 7000
AHP: 19.2

Gms/mile = 0.01

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms
	---	------	-------	----	-------	-------	-------
Initial	3	4.3	4.3	79.5	28.62	0.00	0.00
Hour 1	3	6.3	6.3	80.7	28.62	0.06	0.06
Hour 2	3	6.9	6.9	76.4	28.63	0.02	0.09
Hour 3	3	7.3	7.3	75.6	28.62	0.01	0.10

Test# 3291
Date 12/01/99
Time 14:44
Temp. 75°
SHED: 16
RL to HLS 0:02

Grams= 0.10

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms
	------	-------	-------	-------	-------	-------
Initial	4.4	6.1	72.5	28.65	0.00	0.00
Hour 24	4.6	19.9	72.2	28.95	0.87	0.87

Test# 3292
Date 12/03/99
Time 9:10
Temp. 72°-96°
Bag Vol (in liters): Hybrid
SHED: 11
Soak Time: 39:26

Grams= 0.87

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 005
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

NA

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

NA

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms
	---	------	-------	----	-------	-------	-------
Initial	4	2.3	6.9	97.4	28.15	--	--
Hour 1	4	28.4	85.7	95.6	28.11	2.44	2.44
Hour 2	4	34.2	103.2	95.1	28.09	0.54	2.98
Hour 3	4	40.0	120.7	94.6	28.08	0.54	3.52

Test# 3542
Date 9/18/00
Time 15:34
Temp. 95
SHED: 16
RL to HLS 13:36

Grams= 3.52

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms
	------	-------	-------	-------	-------	-------
Initial	4.1	13.0	72.2	28.50	0.00	0.00
Hour 24	5.4	526.1	72.8	28.49	0.17	39.37

Test# 3544
Date 9/19/00
Time 9:27
Temp. 72°-96°
Bag Vol (in liters): na
SHED: 11
Soak Time: 14:53

Grams= 39.37

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 006
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

NA

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

NA

HOT SOAK EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms
	------	-------	-------	-------	-------	-------
Initial	3.5	18.4	89.7	28.50	0.00	0.00
Hour 1	4.5	1473.1	95.1	28.49	48.34	48.34
Hour 2	7.3	1906.0	95.6	28.47	16.53	64.88
Hour 3	7.2	2212.6	94.7	28.46	13.21	78.08

Test# 3570
Date 10/03/00
Time 14:03
Temp. 95°
SHED: 11

Grams= 78.08

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms
	------	-------	-------	-------	-------	-------
Initial	3.4	14.5	72.5	28.52	0.00	0.00
Hour 24	6.1	709.5	72.5	28.57	54.54	54.54

Test# 3571
Date 10/04/00
Time 14:03
Temp. 72°-96°
Bag Vol (in liters): Hybrid
SHED: 11
Soak Time: 21:00

Grams= 54.54

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 007 - AS RECEIVED
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG	
								Test# 24599
								Date 7/02/01
LA4 1			7.579	133.72	4.388	962	7.46	Time 12:37
Bag	6.544	0.507	7.057	195.14	1.284	826	7.72	Temp: 95°
2 min Idle grams			1.609	33.45	0.304	330		Odom. 243571
LA4 2			4.973	81.82	6.419	1001	7.79	I.W. 7250
Bag	3.626	0.290	3.920	83.16	1.443	865	8.85	AHP: 29.4
2 min Idle grams			1.337	12.25	0.383	334		
LA4 3			4.234	53.16	6.625	1014	8.03	
Bag	3.101	0.222	3.325	54.33	1.631	853	9.40	
LA4 4			5.275	82.26	6.326	1001	7.78	
Bag	3.971	0.304	4.279	90.93	2.055	878	8.63	
2 min Idle grams			1.488	31.88	0.243	329		

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms	
										Test# 24599
										Date 7/02/01
										Time 12:37
	---	------	-------	-------	-------	-------	-------	-------	-------	Temp. 95°
Initial	3	29.3	29.3	95.8	96.4	95.0	----	0.00	0.00	Shed Vol: 7973.5
LA4 1	4	89.4	267.9	100.2	106.3	106.7	7.40	28.72	28.72	Distance: 29.84
2min Idle	4	94.5	283.2	100.3	107.0	108.4	----	1.84	30.55	Barom. 28.68
LA4 2	5	58.2	581.8	99.6	115.4	114.9	7.43	36.07	66.62	Odom. 243571
2min Idle	5	60.1	600.8	98.9	116.4	116.0	----	2.38	69.00	I.W. 7250
LA4 3	5	82.2	821.8	99.0	121.8	118.9	7.49	26.66	95.66	AHP: 29.4
Soak	6	28.1	845.7	94.5	118.9	115.7	----	3.72	99.38	
LA4 4	6	31.0	933.0	98.0	121.6	121.3	7.52	9.91	109.29	
2min Idle	6	31.3	942.0	98.0	122.1	122.7	----	1.09	110.39	Gms/mile = 3.70

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms	
								Test# 3848
								Date 7/02/01
	---	------	-------	----	-------	-------	-------	Time 14:39
Initial	5	2.1	21.1	94.9	28.12	0.00	0.00	Temp. 95°
Hour 1	5	48.5	487.2	94.3	28.10	14.46	14.46	SHED: 16
Hour 2	5	68.5	688.2	94.5	28.04	6.18	20.64	RL to HLS 0:04
Hour 3	5	82.6	829.8	95.1	28.02	4.34	24.97	
								Grams= 24.97

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms	
							Test# 3851
							Date 7/03/01
							Time 11:51
	------	-------	-------	-------	-------	-------	Temp. 72°-96°
Initial	6.3	101.4	71.9	28.56	0.00	0.00	Bag Vol (in liters): 0
Hour 24	5.0	644.3	72.2	28.67	38.76	38.76	SHED: 11
							Soak Time: 18:12
							Grams= 38.76

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 007 - AFTER REPAIR
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

	NMHC	CH4	HC	CO	NOX	CO2	MPG
LA4 1 Bag	4.772	0.391	5.168	149.20	1.303	899	7.76
LA4 2 Bag	3.361	0.216	3.579	60.60	1.514	823	9.60
LA4 3 Bag	5.286	0.306	5.596	89.82	1.669	713	10.23
LA4 4 Bag	3.700	0.220	3.922	61.07	2.215	898	8.87

Test# 24629
Date 7/17/01
Time 10:48
Temp: 95°
Odom. 243668
I.W. 7250
AHP: 29.4

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms
	---	------	-------	-------	-------	-------	-------	-------	-------
Initial	4	11.1	33.3	96.1	96.1	95.0	----	0.00	0.00
LA4 1	4	24.7	74.0	99.1	107.3	106.7	7.47	4.90	4.90
2min Idle	4	25.6	76.7	98.5	108.9	108.4	----	0.34	5.23
LA4 2	4	38.7	116.0	99.1	116.9	114.9	7.39	4.73	9.96
2min Idle	4	39.7	119.0	98.6	117.6	116.0	----	0.37	10.34
LA4 3	4	52.2	156.4	101.9	120.1	118.9	7.20	4.41	14.75
Soak	4	58.6	175.6	96.5	118.2	115.7	----	2.51	17.26
LA4 4	4	67.7	202.9	99.8	122.4	121.3	7.47	3.16	20.42
2min Idle	4	68.4	205.0	99.8	123.0	122.7	----	0.25	20.67

Test# 24629
Date 7/17/01
Time 10:48
Temp. 95°
Shed Vol: 7973.5
Distance: 29.54
Barom. 28.68
Odom. 243668
I.W. 7250
AHP: 29.4

Gms/mile = 0.70

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms
	---	------	-------	----	-------	-------	-------
Initial	5	1.8	18.1	87.2	28.52	0.00	0.00
Hour 1	5	24.9	250.1	94.5	28.48	7.28	7.28
Hour 2	5	33.4	335.5	95.5	28.44	2.65	9.93
Hour 3	5	39.4	395.8	95.1	28.41	1.88	11.82

Test# 3882
Date 7/17/01
Time 12:57
Temp. 95°
SHED: 16
RL to HLS 0:06

Grams= 11.82

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms
	------	-------	-------	-------	-------	-------
Initial	7.9	21.7	72.2	28.64	0.00	0.00
Hour 24	5.8	504.8	72.0	28.59	30.11	30.11

Test# 3884
Date 7/18/01
Time 9:11
Temp. 72°-96°
Bag Vol (in liters): 0
SHED: 11
Soak Time: 17:14

Grams= 30.11

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 008 - AS RECEIVED
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG
LA4 1			4.030	105.52	3.453	1029	7.39
Bag	3.048	0.278	3.329	116.52	1.267	893	8.21
2 min Idle grams			0.612	6.95	0.028	169	
LA4 2			3.036	74.02	3.778	1005	7.89
Bag	2.288	0.173	2.462	80.49	1.313	875	8.84
2 min Idle grams			0.855	5.39	0.028	163	
LA4 3			3.208	73.13	3.737	996	7.96
Bag	2.438	0.174	2.614	83.06	1.414	874	8.81
LA4 4			3.450	78.25	3.438	987	7.96
Bag	2.672	0.186	2.861	87.01	1.691	842	9.03
2 min Idle grams			1.062	6.49	0.036	172	

Test# 24591
Date 6/29/01
Time 13:13
Temp: 95°
Odom. 151107
I.W. 6875
AHP: 26.2

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms
	---	------	-------	-------	-------	-------	-------	-------	-------
Initial	3	6.1	6.1	95.7	96.3	95.0	----	0.00	0.00
LA4 1	4	49.0	146.8	99.5	103.9	102.7	7.45	16.99	16.99
2min Idle	5	16.3	163.3	98.6	104.1	103.7	----	2.02	19.01
LA4 2	5	26.9	268.9	100.0	111.5	109.1	7.45	12.69	31.70
2min Idle	5	27.9	278.9	99.0	111.1	109.7	----	1.27	32.97
LA4 3	5	33.0	329.9	99.9	114.2	112.6	7.44	6.10	39.07
Soak	5	43.5	434.9	95.0	111.7	111.2	----	13.13	52.20
LA4 4	5	45.4	453.9	96.2	117.9	113.6	7.48	2.19	54.39
2min Idle	5	45.5	454.9	95.4	118.2	113.4	----	0.20	54.59

Test# 24591
Date 6/29/01
Time 13:13
Temp. 95°
Shed Vol: 7973.5
Distance: 29.81
Barom. 28.71
Odom. 151107
I.W. 6875
AHP: 26.2

Gms/mile = 1.83

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms
	---	------	-------	----	-------	-------	-------
Initial	5	4.0	40.2	90.0	28.22	0.00	0.00
Hour 1	5	49.3	495.3	95.0	28.15	14.11	14.11
Hour 2	5	53.7	539.5	95.5	28.12	1.34	15.45
Hour 3	5	56.0	562.6	95.5	28.15	0.73	16.18

Test# 3841
Date 6/29/01
Time 15:16
Temp. 95°
SHED: 16
RL to HLS 0:05

Grams= 16.18

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms
	------	-------	-------	-------	-------	-------
Initial	6.1	36.5	72.2	28.60	0.00	0.00
Hour 24	6.9	562.0	71.9	28.59	43.35	43.35

Test# 3843
Date 6/30/01
Time 9:39
Temp. 72°-96°
Bag Vol (in liters): 0
SHED: 11
Soak Time: 15:23

Grams= 43.35

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 008 - AFTER REPAIR
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	NMHC	CH4	HC	CO	NOX	CO2	MPG
LA4 1 Bag	4.441	0.287	4.732	124.87	1.286	1049	7.08
LA4 2 Bag	3.755	0.164	3.920	77.47	1.544	1056	7.49
LA4 3 Bag	2.922	0.194	3.117	93.51	1.474	970	7.92
LA4 4 Bag	3.148	0.198	3.349	96.18	1.798	827	9.03

Test# 24634
Date 7/18/01
Time 11:20
Temp: 95°
Odom. 151145
I.W. 6875
AHP: 26.2

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms
	---	------	-------	-------	-------	-------	-------	-------	-------
Initial	3	6.9	6.9	95.3	96.6	95.0	----	0.00	0.00
LA4 1	3	22.5	22.5	97.2	110.7	102.7	7.40	1.89	1.89
2min Idle	3	23.3	23.3	98.6	109.0	103.7	----	0.09	1.98
LA4 2	3	38.1	38.1	101.2	115.9	109.1	7.34	1.77	3.75
2min Idle	3	38.7	38.7	98.5	114.7	109.7	----	0.09	3.85
LA4 3	3	49.7	49.7	100.8	116.5	112.6	7.41	1.31	5.16
Soak	3	64.5	64.4	95.9	113.5	111.2	----	1.85	7.01
LA4 4	3	75.9	75.8	99.6	113.5	113.6	7.45	1.33	8.34
2min Idle	3	78.4	78.3	96.4	111.3	113.4	----	0.36	8.69

Test# 24634
Date 7/18/01
Time 11:20
Temp. 95°
Shed Vol: 7973.5
Distance: 29.60
Barom. 28.78
Odom. 151145
I.W. 6875
AHP: 26.2

Gms/mile = 0.29

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms
	---	------	-------	----	-------	-------	-------
Initial	4	3.8	11.5	83.7	28.44	0.00	0.00
Hour 1	4	35.8	108.0	95.7	28.37	3.01	3.01
Hour 2	4	52.6	158.7	95.5	28.30	1.57	4.58
Hour 3	4	63.5	191.6	95.2	28.25	1.02	5.60

Test# 3887
Date 7/18/01
Time 13:24
Temp. 95°
SHED: 16
RL to HLS 0:06

Grams= 5.60

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms
	------	-------	-------	-------	-------	-------
Initial	9.1	13.0	72.0	28.59	0.00	0.00
Hour 24	14.5	164.3	71.9	28.61	10.14	10.14

Test# 3888
Date 7/19/01
Time 9:53
Temp. 72°-96°
Bag Vol (in liters): 0
SHED: 11
Soak Time: 17:29

Grams= 10.14

Heavy-Duty Gasoline Truck

Test: Sequence Summary
Vehicle: 009
Fuel Type: Commercial Grade Cal. Phase II

RUNNING LOSS EXHAUST EMISSIONS TEST (Grams/mile)

Modal Data	**NMHC**	**CH4**	**HC**	**CO**	**NOX**	**CO2**	**MPG**	
								Test# 24686
								Date 8/07/01
LA4 1								Time 11:48
Bag	0.572	0.120	0.693	16.40	1.090	801	10.76	Temp: 95°
2 min Idle grams			0.076	0.03	0.161	324		Odom. 126290
LA4 2			0.401	7.12	3.181	879	10.01	I.W. 4500
Bag	0.257	0.070	0.328	5.57	1.225	748	11.78	AHP: 11.9
2 min Idle grams			0.087	0.11	0.142	320		
LA4 3			0.407	7.10	3.093	931	9.46	
Bag	0.280	0.067	0.348	5.61	1.374	821	10.74	
LA4 4								
Bag	0.397	0.074	0.472	7.31	1.677	774	11.33	
2 min Idle grams			0.080	0.09	0.140	338		

RUNNING LOSS EVAPORATIVE EMISSIONS TEST

	P-Cell R	FID Defl	SHED ppm	Avg Temp	Fuel Temp	Fuel Target	Dist.	Net Gms	Cum Gms	
										Test# 24686
										Date 8/07/01
										Time 12:04
	---	------	-------	-------	-------	-------	-------	-------	-------	Temp. 95°
Initial	3	11.8	11.8	95.5	96.6	95.0	----	0.00	0.00	Shed Vol: 7973.5
LA4 1	3	42.0	42.0	100.2	109.8	106.4	7.48	3.61	3.61	Distance: 29.91
2min Idle	3	53.8	53.7	100.0	110.7	105.9	----	1.42	5.03	Barom. 28.60
LA4 2	3	81.1	81.0	99.2	116.8	114.5	7.49	3.29	8.32	Odom. 126290
2min Idle	4	29.7	89.0	100.0	117.5	113.2	----	0.94	9.27	I.W. 4500
LA4 3	4	41.3	123.8	97.1	121.2	119.1	7.45	4.25	13.52	AHP: 11.9
Soak	4	54.0	161.8	96.1	117.6	115.1	----	4.63	18.15	
LA4 4	4	64.4	193.0	100.1	123.5	119.9	7.50	3.60	21.76	
2min Idle	4	68.6	205.6	101.1	121.9	117.7	----	1.47	23.23	Gms/mile = 0.78

HOT SOAK EVAPORATIVE EMISSIONS TEST

	FID#16 R	Defl	SHED ppm	Avg Temp	Baro	Net Gms	Cum Gms	
								Test# 3937
								Date 8/07/01
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Initial	3	146.7	147.4	88.1	28.32	0.00	0.00	Temp. 95°
Hour 1	4	69.0	208.2	95.8	28.30	1.83	1.83	SHED: 16
Hour 2	4	89.3	269.5	94.9	28.38	1.95	3.77	RL to HLS 0:06
Hour 3	4	91.9	277.3	95.5	28.42	0.25	4.02	
								Grams= 4.02

DIURNAL EVAPORATIVE EMISSIONS TEST

	Shed PPM IN	OUT	Avg Temp	Baro	Net Gms	Cum Gms	
							Test# 3939
							Date 8/08/01
							Time 13:38
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Initial	7.9	33.8	75.1	28.65	0.00	0.00	Bag Vol (in liters): 0
Hour 24	8.7	220.8	72.3	28.67	15.81	15.81	SHED: 11
							Soak Time: 20:30
							Grams= 15.81